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AGRICULTU

BY

P. G. GENNADIUS.

PART III.

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REPORT

ON THE

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PART III.

THE object of this Third Part of my Report is to point out the means which would be most suitable in Cyprus for the agricultural training of its peasants and to describe those diseases of plants which I have met with in the course of my excursions over the Island.

Although these two subjects do not at first sight seem to have any connection with each other, they are, nevertheless, related; because without the diffusion of some knowledge we cannot expect that landowners in the Island, for the most part ignorant, would generally and of their own will apply any measures in order to prevent the development and spread of the diseases of plants, which, as we shall see, have everywhere made themselves more perceptible during recent years. For this object the diffusion of some elementary agricultural knowledge is indispensable; because only by such knowledge will it be possible to uproot long-established prejudices and erroneous ideas existing among our peasants with respect to the nature of the diseases of plants and the origin and life of the parasites producing them.

CHAPTER A.

ON THE AGRICULTURAL TRAINING OF PEASANTS IN CYPRUS.

Superior agricultural education is now everywhere the fashion. Schools and Academies of Agriculture are everywhere established; and to them resort young men of every class and every nationality, sometimes of an unfit constitution, whose chief object is to acquire a diploma, viz.: the entrance ticket, by which they will be allowed to follow a new career, supposed to afford comfort and liberal compensation, to enter upon a road far easier than those long since overcrowded by jurists, doctors, literary men, engineers, and other votaries of what are called the liberal professions.

With respect to countries which are great, prosperous and advanced in agriculture the establishment of superior agricultural schools is justifiable; because in those countries there are to be found experienced and accomplished teachers and abundant means for the regular working of such establishments, and students, on leaving school, generally find employment more easily by being appointed themselves as teachers or entering the civil service.

p 5879

Besides, the maintenance in those countries of such superior schools of agriculture is also justified on another ground. Being well organized and managed on strict principles by a staff of acknowledged ability, taking advantage of the reputation of those who teach in them and of the prestige of the country in which they are established, attract many foreign students, who by the fees they pay and by the other expenses to which they are subjected during the time of their education, yield to the country a not despicable revenue. That this source of revenue is taken into serious consideration is proved by the leniency and condescention shown by the managers of these establishments with regard to the admission and the granting of certificates to all foreign students.

Nevertheless, the plethora of scientific agriculturists without occupation soon became perceptible, especially in those countries which have been most productive in them, such as France and Italy. To restrict this evil in France, for the last three years more qualifications than formerly are required from those who apply for admission to the superior agricultural schools, and in Italy the abolition of two out of three central agricultural establishments has been decided upon lately.

This mania for superior agricultural knowledge which, as we have seen, is justifiable in Western Europe, has taken hold of us in the East as well; who, as in so many other things, so in this, superficially imitate what takes place in Western Europe under other conditions and circumstances.

Against, therefore, the opinion of those who can sincerely and thoughtfully pronounce on the question (1), schools of agriculture have also been established here, which for want of the necessary means, and especially, of an experienced staff of teachers and want of management, little by little, and sometimes in violation of existing regulations, became of necessity mere schools of theory. Thus we now see declining schools of agriculture in Roumania, Greece and elsewhere.

But the greatest mistake in establishing in the East schools of agriculture in general is the following: on the one hand peasants' children do not go to them both on account of the prevailing ignorance of our peasants as well as on account of the economic and civil conditions under which agriculture exists; and, on the other, the sons of well-to-do landowners, even when they go to these schools (which seldom happens), do not afterwards devote themselves to cultivation or to the mere superintendance of their property, not even as much as their parents had done, who mostly by their assiduity managed to acquire and improve their property.

Therefore by the schools of agriculture established in the East a class is formed of place-hunters, who are very rarely employed by landowners, because these latter require practical and experienced managers and superintendents, capable by their personal weight to impose themselves on the peasants, who, as a general rule, are uncouth and cunning, and to discharge easily and efficiently a variety of administrative and commercial duties in connection with the property, having to come in contact every day with the administrative, judicial and municipal authorities of the district in which the property under their management is situated.

(1) See "*Hellineki Georgia*" of the year 1894, pages 80, 113, 137 and 417.

Hence those who come out of schools of agriculture, being rejected by landholders, seek public posts. But these are always of a limited number and therefore quickly filled up. Consequently new posts are created; but they are also speedily filled up by the most fortunate, the remaining, who form the majority, being left out in the cold. Nevertheless, the number of agriculturists without occupation is annually increasing, because the schools every year turn out more graduates. The most intelligent, most decided, ablest and most fortunate of them turn their attention to other careers; whilst the others, who are more numerous, continue fleecing their parents, who curse the moment schools of agriculture were established, which thus become unhealable wounds in countries not yet ripe or by nature unsuitable for utilizing agriculturists, who may, perhaps, be thoroughly accomplished in theory but who do not possess the necessary practice, experience, authority and, sometimes, health, which are indispensable qualifications for the successful management or even simple superintendence of an estate.

This picture of the results proceeding from the establishment of schools of agriculture in general in countries unsuitable for them is a real one, has been copied from nature and it is not at all exaggerated. I have thought it necessary to give here a detailed description of it because in my travels in Cyprus I discerned symptoms of this epidemic, which ravages other Eastern countries. I came across several persons in Cyprus, who suppose that by establishing there a school of agriculture it would be possible to train agriculturally the peasant population of the Island, and, consequently, to improve its agricultural condition.

But since by schools of agriculture it is not possible to give an agricultural training to our peasants, by what means are we to secure this end, which is, undoubtedly, most conducive to the advancement of agriculture in every country?

Agricultural training of peasants can everywhere, and particularly amongst us, be achieved through priests and teachers. As I wrote on another occasion, they elsewhere, properly trained, are not only teachers of faith and of knowledge, but very handy, convenient and cheap vehicles for propagating amongst the people morality, good behaviour, love and reverence to God and to the State, as well as teachers of those elementary and useful items of knowledge which peasants and landowners require.

Therefore, it would be well to introduce in the Gymnasium at Nicosia, which is the nursery of schoolmasters in Cyprus, and which in other respects is perfectly organized, practical teaching in agriculture and natural history; and then out of those who distinguish themselves in these subjects to select the teachers required for the agricultural districts of the Island. The necessary steps should also be taken for the establishment of an *agricultural* seminary after the model of that working for several years past near Canea, in Crete, the foundation and maintenance of which are due to the practical mind and generosity of the ever to be remembered M. Gerasimo Stratigaki, bishop of Kissamo and Seleno. (1). Let then only the graduates of such an establishment be ordained priests in agricultural districts.

(1). See "*Helliniki Georgia*" of the present year (1895), page 186.

Such teachers and priests will render, within a very short time, to agriculture in the Island real services, such as, under the present conditions of agriculture, by no other means could be secured.

Everywhere, particularly in the East, priests and teachers are the advisers of the peasant an every emergency, especially when by their conduct they manage to acquire his good opinion and esteem.

Their opinion on every subject, which in a circle of peasants may provoke a discussion and which presents some doubts, is held in respect at least by the majority. The teacher or the priest is the person who reads the newspapers and explains and comments upon their contents within the hearing of all during the hours of leisure. Whenever I visit a village for the purpose of giving some advice in agriculture, at the meeting of the peasants, readily held for the occasion, the presence of the teacher or the priest is indispensable, in order that they, understanding, as they are supposed to do, things better, explain afterwards to the peasants the reports published. Let then teachers and priests acquire the necessary agricultural knowledge, because through them it is possible to impart to our peasants, quickly and without expense, that knowledge by which agriculture advances and the condition of the peasants improves.

The satisfactory results of the agricultural training of teachers and of the instruction given at grammar schools situated in agricultural districts on subjects connected with agriculture become manifest so quickly, that this system of training the peasants is now by preference put in to execution everywhere.

Besides, what is there more reasonable and just than to impart to the children of peasants the elements of the business which will engage them throughout life ? Having this in view, Emile Jacquemin said that "the chief educational principle consists in teaching each person what his social class renders necessary—nothing more or less." (1). On the ground of this principle a Special Commission in England recommended the teaching of agriculture at the Grammar Schools in Ireland (2).

Entertaining the same opinion, the Society of Agriculturists in France rewards every year those who have taught agriculture most effectively at the Grammar Schools of many districts of that country (3).

Lastly, Borlée, who has repeatedly taken prizes in Belgium for the educational system applied by him, and who holds these principles, says that the prospectus of lower and even of secondary education must be freed from the various useless subjects which burden it, and these must be substituted by the elements of natural sciences and of agriculture ; because the most perfect system of lower education consists in teaching not only reading, writing and arithmetic, but also in imparting the knowledge which is needed by most people. Such exactly is the instruction given at the Grammar Schools in the United States of America. (4).

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(1) L'agriculture de l'Allemagne, page 4.

(2) The Journal of the Agricultural Society of England, Oct., 1885, page 536.

(3) Bulletin de la Société des Agriculteurs de France—Session de 1895, page 139.

(4) L'enseignement primaire agricole, page 4. 3eme Congrès International d' Agriculture. Bruxelles, 1895.

A teacher versed in the elements of natural history, chemistry and agriculture will be able to teach his young pupils as well as their parents what is essential in everything regarding the growth and the life of plants and animals. By obtaining this knowledge peasants will be freed from their many prejudices, which very often occasion so much damage to their agricultural work. Such a teacher will pursuade the peasants to give up, out of regard to their own interests, treating animals in general with cruelty, and to spare all insectivorous birds, the frog, the lizard, the hedgehog, the tortoise, creatures which in our countries are not only harmless but even most useful, feeding as they do almost exclusively on insects and other animals destructive to agriculture. And, lastly, such a teacher by his advice will contribute in preventing the departure of capital and hands from the fields by the gradual resorting of the richer peasants to towns ; because by his teaching and example he will persuade them that the profession of the agriculturist is the noblest, most liberal and healthy, just such as our ancestors described it, who, amongst other observations said :

" What other profession renders the body more capable to run, to throw a missle and jump than agriculture ? What other profession yields greater rewards ? What other profession receives its votaries more agreeably, offering to all comers all that is useful ? Which entertains more strangers ? Where is greater comfort than to pass the winter in a village by the side of an abundant fire and in the enjoyment of hot baths ? Where are water and air and shades sweeter than in the country ? Which profession offers to the Gods more suitable offerings or renders fairs more perfect? Which is dearer to the workman, more agreeable to the wife, more charming to the children, more pleasant to friends ? To me it will seem surprising if anybody can devise a more agreeable occupation or one more useful to men than agriculture. Besides the earth, wishing to teach those who are capable of learning, teaches them also justice, by munificently rewarding those who attend to her best." (Xenophon's " Eeconomicos," cap. 5, secs. 8-12.)

Chapter B.

Diseases of Plants.

The great development of the means of communication and of commerce which has been effected during the present century has greatly contributed to the spread of a great number of diseases of plants from one country to another.

The *Oidium Tuckeri*, the *Phylloxera vastatrix*, the *Peronospora viticola*, the black rot (*Guignardia Bidwelli*), the *Phytophthora infestans*, the *Doryphora 10-lineata*, are American parasites brought to Europe principally by the plants on which they live.

By the same means Europe, Asia and Africa bequeathed to the New World a great number of parasites formerly unknown there. Thus Howard says (1) that out of the hundred scale insects which attack plants in the United States, about forty are of foreign origin. Of

(1) Insect Life, vol. VII, page 333.

foreign origin are also a great number of parasites to be met with now in America, the most destructive of which is, undoubtedly, the *Cecidomyia destructor*, a century ago imported into that continent from Germany (1).

Towards the spread of diseases of plants from one country to another greatly contribute also international exhibitions, because the various agricultural products, and especially fresh and dry fruits of all sorts, exhibited there, serve as a vehicle of the germs of these diseases.

Decaux, in a special detailed treatise (2) has defined and described a great number of injurious insects found on foreign products exhibited in the Paris International Exhibition of 1889 a similar work was carried out by Riley during the Chicago International Exhibition of 1893 (3). It has been observed—although all the causes have not been ascertained—that parasites transported by all these various ways from one place to another become as a general rule much more injurious than they are in the countries they come from.

Moreover, the injury done by parasites, whether native or imported from abroad, are now everywhere more perceptible; because the cultivation of different products has everywhere been extended and more or less specified, and at the same time the cost of cultivation has increased and, consequently, the interest of cultivators in the proper growth of plants and in the safe gathering of their products has become greater.

Nevertheless everywhere most cultivators, by negligence or by a badly understood economy, do not particularly show their interest when they have to deal with parasites which attack their plants. These parasites very seldom attract their attention when they are few or when they make their appearance on limited extents of land. Being thus left unpursued and helped by favourable atmospheric conditions they very frequently multiply themselves and become most injurious. Then their injuriousness becomes perceptible to everybody and the expense necessary for their extirpation being immeasurably greater, the landowner in view of its magnitude retreats all in a tremble, and, crossing his arms, awaits help from others.

Our peasants being even influenced by so many prejudices, and sometimes believing in fatality, seldom apply with the necessary care and precision the proper measures for protecting in time or freeing their plants from the parasites attacking them (4).

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(1) Harris. Insects Injurious to Vegetation, page 568.

(2) Etudes sur les insectes nuisribles recueillis à l'Exposition Universelle. Paris, 1890.

(3) The Insects occurring in the Foreign Exhibits of the World's Columbian Exposition.—Insect Life, vol. VI., page 213.

(4) Most peasants in the East, although they rear or see reared silkworms, and, consequently, know that they come out of the eggs of the same insect, nevertheless they fancy that other insects, similar or not, which attack their seeds and plantations, come forth spontaneously. The same opinion I have heard repeated by experienced, intelligent and, in other respects, most judicious landowners in many countries of Western Europe, who even laughed ironically at the principle of *Omne vivum ex ova*. It is not, of course, to be wondered at that on this subject they are labouring under a delusion, considering that it is only twenty years ago that the theory of the spontaneous origin of beings was definitely overthrown, thanks to the studies and experiments of Pasteur. Before that period eminent scientific men entertained and upheld this theory even in their school manuals. (See, among other works, what is taught in the "Manual of Zoology for the use of students," New York, 1872, by Dr. Nicholson, Vice-President of the Geological Society of Edinburgh).

It must be remembered that it is not only peasants in the East who entertain such prejudices. Only a few years ago in some parts of Europe the *Ustilago segetum* was looked upon as increasing the production of cereals; and in some parts of England, particularly in the county of Norfolk, according to Jensen (1), this parasite "is regarded with a superstitious reverence" by peasants.

But even supposing that some cultivators, who may be free from prejudices and who take a proper account of things, proceed in good time and with diligence against parasites which may have invaded their property, their endeavours and the expense they incur prove for the most part futile, because the one-sided pursuit of most parasites cannot definitely free the property attacked so long as in adjacent properties the proper measures are not applied.

For all these reasons in many countries the authorities compel the cultivators to proceed against the parasites which attack their seeds and plantations or they undertake themselves the carrying out of the measures necessary for the extirpation of these parasites. Thus in France, during the first Republic, a Law was passed (Loi de l'échenillage, of the 15th March, 1796), by which the pursuit of injurious insects and especially of caterpillars became obligatory on the interested parties. This Law remains in force to this day in France, where it is applied by the Prefects when they deem it necessary. Thanks to the special laws in force in France, Italy, Switzerland and other vine-growing countries, it has been possible to arrest or to restrict the speedy spread of the *Phylloxera* in districts in which landowners refused to take the necessary means for putting a stop to this evil.

Otherwise the successful pursuit of locusts and caterpillars attacking apple trees by the Cyprus administration, is it not due to a special law by which the money necessary for the extirpation of these insects was secured?

Therefore the taking of Legislative measures becomes indispensable everywhere, and particularly in countries where, in consequence of various reasons, cultivators are not willing to free in time their seeds and plants from parasites.

This being established, I will now examine the most common and injurious parasites which I have come across during my journey through Cyprus.

Parasites of the Vine. Mouillefert (2), who visited the Island four years ago, has pointed out many parasites of the vine in general; but of these only two are those which periodically cause considerable damage, according to the experience of vine-growers in the Island and to my own observations. These are the *Oidium Tuckeri* and the *Procris ampelophaga*.

The *Oidium* is a mould of American origin imported into Europe fifty years ago. This parasite seems to have attacked the vineyards of Cyprus

(1) The propagation and prevention of smut on oats and barley. In the Journal of the Royal Agricultural Society of England, vol. XXIV., part 11, 1838.

(2) Report on the Vineyards of Cyprus.

for a long time past (1), for which reason vine-growers in the Island know perfectly well the symptoms of the disease produced by it and the effectual means for its prevention—the sulphur cure. Nevertheless, in consequence of the hot and dry weather usually prevailing there during the period of sprouting, as well as on account of the rather low pruning of vines customary throughout the Island, the injury done by it is not always felt by many.

In countries where this parasite has once penetrated, its germs are constantly to be found in the atmosphere, on the ground or on the vines, and they germinate on the first appearance of favourable conditions.

As I wrote on another occasion, the *Oidium* in order to germinate must have a damp atmosphere and its temperature must be above 20 degrees (centigrade). The more the atmosphere becomes hot, the more the disease acquires vigour. When, however, the temperature goes beyond 38 degrees the disease becomes milder and at 45 it is altogether powerless.

When the conditions favourable to the growth of this parasite do not appear, it is possible for the *Oidium* not to make its appearance in a country to an extent which would cause the vines any perceptible injury. Nevertheless, its appearance in a mitigated form is not a proof of its utter extinction. A careful and experienced observer during the period of sprouting, looking at the vines of a country which was once attacked by the *Oidium* will always find some corner of the vineyard or even some isolated vines on which it lurks, growing feebly, perhaps (for which reason it is not as a general rule remarked by everybody), but still sufficiently in order that it may serve as a centre for the spread of the evil on the appearance of more favourable atmospheric conditions.

The *Oidium* is not developed with the same intensity on all the vines. Those which are more slender and have thinner foliage are the most easily attacked, whilst those with tougher and downy leaves are less subject to attacks. Moreover, for years it has been observed that the shoots of the vine nearest to the ground are less subject to the attacks of this parasite, and for this reason, from the time it invaded our vineyards and before the sulphur treatment was devised, the system of training the vine on the surface of the ground (en chaintres) was in many parts applied, which is ever since in use in some vineyards of the Peloponnesus and prevails from time immemorial in the islands of the Ægean Sea. There, as well as in the midland parts of Attica, where the vines are kept very low in consequence of the dryness of the atmosphere and of the ground, the sulphur treatment is not used because the *Oidium* very seldom causes any real damage under such conditions.

The same causes, viz.: the low pruning (2) and the special atmospheric conditions have had the same results in Cyprus, that is to say, the *Oidium*, as a general rule, does not present itself with intensity, and, consequently, people do not treat the vines with sulphur. There are, however, districts in the Island (and especially along the southern moun-

(1) In 1855, Gaudry found the *Oidium* in Cyprus. For the history, symptoms and means of prevention of this disease of the vine, see "*Helliniki Georgia*" of 1885, pages 114 and 141.

(2) In Cyprus I only came across one vineyard (near Larnaca) in which high pruning is applied.

tain range, which is pre-eminently vine producing), in which the atmospheric conditions suitable for the propagation of the *Oidium* not seldom present themselves. The presence of these conditions during a series of consecutive years may, if the necessary treatment be not applied, destroy entire vineyards, as seems to have happened at Omodos a few years ago.

It is therefore indispensable to apply the sulphur cure at least in those districts of the Island which are most subject to the attacks of the parasite. This treatment may now be introduced in Cyprus more easily than formerly in consequence of the great depreciation of sulphur, the common quality (brimstone) which costs at Catania, in Sicily, fr. 5.75 per 100 kilogr. (f.o.b.)

It is indisputable that flowers of sulphur are more effective than brimstone. Nevertheless the latter is preferred because it is twenty per cent. or even cheaper than the former, and which, being ground, is easily converted into a similar fine powder, with which the vine is powdered over during the period of sprouting.

Usually three powderings with sulphur take place ; the first is done a few days before blooming, when the shoots of the vine are 3-5 inches long, generally with the dredge box. This implement is a cylindrical vessel, in which the powder is put, the lid having many fine holes. This first sulphur cure is the most important ; its successful application in point of time and manner of execution decides the fate of the crop. The second powdering must be done after the formation of the fruit, and the third when the grape attains about half its natural size. Sometimes when the weather continues damp and the disease seems persisting in some parts of the vineyard, or when on account of wind or rain the sulphur powder on the vines is removed, it is necessary to repeat the powdering.

But, on the other hand, two powderings only are generally sufficient. The vine-grower is taught these details by experience.

Excepting the first powdering, which, as I have already said, is done with the dredge box, all the others are done by the sulphuring bellows, there are various systems of bellows, but of all those which I have seen and tried those used in the Peloponnesus are indisputably the simplest, and, consequently, the most useful and at the same time the least expensive.

During the first and second powdering all the green parts of the vine are powdered, whilst during the third only the grapes. For the first two powderings 8 to 15 okes of sulphur per stremme are required, the third can be done with only three okes.

As I have reported to the French Academy of Sciences (1) and I afterwards stated in my treatise (2) on the *Oidium*, the sulphur acts on the parasite both mechanically and chemically. The sulphur powder, covering the tender surfaces of the vine and thus preventing them from coming in contact with the germs of the *Oidium* which are about in the atmosphere, impedes the development of the disease mechanically, just as any other fine powder would do. This may be observed in vines

(1) Sur le soufrage de la vigne en Grèce. Par P. Gennadius. Comptes rendus de l'Académie des Sciences, 12 Février, 1883, page 423.

(2) On the disease of the Vine, viz.: on the *Oidium Tuckeri*, page 14.

growing by the side of dusty roads ; all parts of these vines during almost all the period of shooting being covered by a stratum of fine dust, even without the use of sulphur are rarely attacked to any serious extent by the *Oidium*. But this truth has only a theoretical value, because neither by sulphur nor by any other dust is it possible or economical that all the tender parts of the vine should be covered during all the period of their shooting. The wind or the rain will at last remove the dust gathered on the vine, or the dust may completely cover only the parts of the vine which look upwards. Exactly for these reasons vines by the side of dusty roads, although they are not seriously attacked, do not, nevertheless, avoid the more or less light but regular attacks of the *Oidium*.

Consequently it is not so much the powder of sulphur as the sulphur vapours, which are created in a damp and hot atmosphere, that prevent the development of the germs of the *Oidium*, which are destroyed by these vapours. This is the result of my attentive observations during a long series of years.

As I wrote on another occasion, the sulphur powdering is considered successful when it is done on a calm, clear, not rainy, and very warm day. This atmospheric condition must last 24 hours after the powdering in order to prove beneficial. If before this length of time the weather happens to change, the powdering must be applied again, or else the *Oidium* may make its appearance anew. After powdering, if the weather be favourable, from the vineyard a heavy sulphur smell is emitted which fills the atmosphere and lasts the whole day. After the lapse of the 24 hours, during which the vines are covered by sulphur vapours, if the disease had already appeared its further devolopment is stopped ; but if it had not as yet manifested itself, it does not break out for some time, perhaps for a month, after which a new powdering must take place.

Procris ampelophaga (1) is a microlepidopterous insect, seldom met in Greece (2) and France but very common in Italy. In Cyprus, as I, at least, was able to judge, this is the most common and most injurious to vines insect. Its caterpillar the Cypriots call *sirividi*.

The caterpillars of the *Procris ampelophaga*, which towards the middle of the month of April appear on the yet young shoots of vines, attack them from the evening until the morning. During the day avoiding the light and the hot rays of the sun, hide themselves and keep quiet amongst the leaves, which are still small, or under them. In this way they live for 25 to 30 days, causing sometimes great damage to the vineyards which they attack. About the middle or the end of May, when they have acquired their biggest size, retiring to the fissures of the bark of vines or of adjacent trees, weave their coccons in which they take the form of chrysalides and a few days afterwards, about the beginning of month of June, they come out of them in the form of moths.

The moths of the *Procris* fly very little and slowly, consequently they do not travel far from the vine on which or near which

(1) Synonyms. *Zygaena ampelophaga*, *Procris vitis*, *Atychia ampelophaga*, *Ino ampelophaga*.

(2) I only once met it in Greece.

they have undergone their transformation and under the leaves of which they rest during the day.

The female ones become fecund quickly and soon after they deposit on the shoots of the vine their many little eggs in order, the one near the other and in groups of two to three hundred. In ten or twelve days, viz.: about the middle of June, out of these eggs the young caterpillars of this second generation are hatched, which immediately begin devouring the most tender parts of the vine. In this way they continue feeding themselves until the middle of the month of July when they undergo their transformation into chrysalides, weaving their cocoons as their parents had done in the fissures of the bark of vines or other adjacent trees.

In hot climates, as that of Cyprus, the strongest and earliest of the insects of this second generation are transformed into moths about the beginning of August. Thus a third generation of the *Procris* makes its appearance within the same year. But this last generation, on account of the advanced state of growth of the vine, cannot inflict but an insignificant injury on the vine. However, the latest insects of the second generation, which are also the most numerous, pass the winter in the form of chrysalides within their cocoons and are transformed into moths about the beginning of the following April. From their egg-laying proceed the small caterpillars which make their appearance on the yet young shoots of the vine about the middle of this month.

The period of the appearance of these three generations of the *Procris* may be earlier or later according to the climate of each district and the early or late advent of spring. However, the appearance of the first generation almost always coincides with the commencement of the shooting of the vine, and for this reason it becomes most injurious.

To combat these caterpillars they recommend :

(1) To remove during the winter from the trunk of the vine and burn the old bark, in the fissures of which, as we have seen, the *Procris* mostly weaves its cocoon and passes the winter ; (2) to scald (*échauder ébouillanter*) during the same period the trunk, viz.: to pour over it hot water, which while it does not at all injure the vine, destroys the chrysalides which pass the winter under the old bark ; (3) to gather, in the spring, and destroy the caterpillars, and (4) to sprinkle at the same period the young shoots with a solution of some substance poisonous or in any case injurious to the caterpillars feeding on them.

The first method is easily carried out when long pruning is applied to vines. Then, during winter and after rain the old bark, which hides the chrysalis of the *Procris* as well as the germs of various other parasites, is easily removed from the trunk. But in Cyprus the vine is pruned low and thus near the surface of the ground a stumpy and very irregular head is formed. Consequently it becomes very difficult if not impossible to take off the bark of such stumpy trunk.

The method of scalding is successfully applied in many parts of France against the *Pyralis* and the *Cochylis* of the vine. The water used for this purpose must have a temperature not higher than 70-80 degrees (centigrade). But since it cannot retain the same temperature for long if transported from a distance, portable boilers are used which are

specially made for the purpose (1). Out of these the water is thrown against the trunks of the vines by a caoutchoue pipe or it is taken at intervals in a small vessel (2) by which they are copiously washed on all sides. Before this work begins the vines must be dug all round, in order that the hot water may reach even the part of the trunk which is under the surface of the ground. The scalding begins by preference after pruning, but not after rain, and it is performed when the weather is fine and when no violent or cold wind blows. This work must finish when the buds of the vine begin to swell, because then the hot water may injure them. This system applied in proper time methodically proves very effective.

The gathering of caterpillars during spring is also an effective method, capable of saving even the standing crop ; but having to be performed by paid labourers it becomes expensive, and for this reason landowners avoid using it. Many industrious vine-growers however who, helped by their families, do the work themselves, manage by this very simple means to free their vineyards from the attacks of the *Procris*. The gathering and destruction of the caterpillars is easily accomplished with a long needle, by which they are pierced and detached from the sprouts of the vine.

Lastly, an excellent means has been found to be the sprinkling at the beginning of sprouting of the vine attacked by the *Procris* with a solution of poisonous or insecticide substance.

The solution of soap and Pyrethrum, recommended by Dufour, has proved most effective against all insects which in the form of caterpillars attack the green parts of plants. This solution is prepared and used as follows :

In a spacious vessel containing ten okes of hot water are dissolved three okes of soap ; to this an oke and a half of fresh powder of Pyrethrum is added, after which the whole is well stirred with a broom and thinned by adding ninety okes of cold water.

This preparation of Dufour, which I have myself tried successfully, may be procured from Siegfried, druggist, in Zefingue, Switzerland, all ready and concentrated, and it may be thinned for use at will by adding to it cold water.

It is used with the help of a spraying pump (pulversisateur) as soon as the caterpillars make their appearance, in the morning by preference. If the caterpillars are numerous a second spraying takes place 5-10 days afterwards.

An effectual remedy is also said to be Pitteleina (3), prepared in Padova, according to a recipe by Berlese, and which is in considerable use in Italy. By a solution of this substance in water (in the propor-

(1) One of the best is the Chaudière à ébouillanter, système Montoy.

(2) As metals get quickly chilled, the vessel by which the hot water is taken out of the boiler, if made of metal, must be covered by some woollen cloth. Vessels specially adapted to this purpose are made in France and are called cafetières à échauder.

(3) Pitteleina is prepared by A. Petrobelli and Co., Padova, Italy. A short time ago this factory sent to me for trial two vases of Pitteleina, the effectiveness of which I have not as yet had the opportunity of ascertaining.

tion of 1 to 2 parts of Pitteleina in 100 parts of water), the vines are sprayed just as with the solution of soap and Pyrethrum.

Both these remedies kill caterpillars as soon as they come in contact with them, whilst to kill them by poisons, insects must eat the leaves sprayed or powdered by the poisonous substance.

The poison most commonly employed for the purpose is arsenic, which has always been used against various injurious insects. Nevertheless, more general use of it was made in the United States about twenty-five years ago against the *Doryphora*, which had attacked potatoes, in the form of Paris green (1). Now great use is made of this substance both in America and in England, in a state of powder or in a solution, against a great many leaf-eating insects.

Of this solution trials on a small scale have been made in Cyprus against the *Procris*, which seem to have succeeded.

The only unavoidable defect of poisons is the danger involved in their use by peasants, especially the less intelligent ones, whose negligence often has very disagreeable consequences. But in view of the effectiveness and cheapness of the remedy this defect must be overlooked ; such at least is the opinion of Americans, who make use of poisons on a large scale.

In any case we may say there are now no difficulties in preventing the damages of the *Procris*. As this insect is not easily transferred and, consequently, not easily propagated from one vineyard to another, the vine-grower who uses one or more of the above-mentioned methods may safely and definitely free his property from this scourge even if his neighbours continue abandoning their vineyards to the mercy of the *Procris*.

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(1) About twenty-five years ago, whilst a student in the Champaign University in Illinois, the use of Paris green was devised by a land-owner against the *Doryphora* 10-*lineata*, which a few years before had invaded that State. I shall never forget the pleasure we all felt at the perfect success of the trials made in connection with the effectiveness of this remedy and which we carried on in the experimental fields of that establishment, under the guidance of the then and now Professor of Botany and Horticulture, Dr. T. I. Burrill.

I also remember that, as always happens under similar circumstances so on that occasion, many, in spite of the satisfactory results of these trials, continued expressing doubts as to the efficacy and safe use of the remedy.

Since that time the use of the Paris green became general throughout North America, not only against the *Doryphora* but also against many other leaf-eating insects. There are now large factories which prepare the substance, of which the United States consumes annually about 2000 tons and Canada about 400 tons.

This substance is used in some cases in a state of powder mixed with flour and in others diluted in water. Both the powder and the solution must be well mixed, during the preparation as well as when used, for, otherwise, if a part of them is used thinner or thicker than is necessary, it will either not have the required effect or will injure the plants treated.

In England, where, thanks to the efforts of Miss Ormerod, the use of the Paris green began five years ago to become general, to prevent its unequal thickness when diluted with water, this substance is prepared in the form of an ointment and is sold in bottles by Blundell, Spence and Co., 9, Upper Thames St., London. As we shall see lower down, against the apple caterpillar the Cyprus Government made successful use of this preparation, which, although in a smaller degree, presents also the defect of putty precipating.

Diseases of Citrus Fruit Trees. The diseases of Citrus trees most commonly to be met with in Cyprus are the *Scales* and the *Mal-di-Gomma.*

The *Scales.* Almost all scales from a certain period of their lives attach themselves and, as a general rule, remain immoveable on the most tender and usually aerian parts of plants, where they feed, grow and multiply themselves until the end of their existence.

The Citrus trees are subject to the attacks of a great number of scales, of which the one most frequently met in the East is that first observed by me in Chios in 1880, and named *Aonidia coccinea* (1).

The multiplication of this scale is very quick and its destruction by the means usually employed very difficult, because the laying of its eggs and the hatching of its young ones are carried on almost uninterrupedly from the month of April to the last hot days of Autumn.

I have often met this insect on other plants besides, such as the vine, fig, mulberry, mastic shrub, *Pistacia lentiscus*, rose trees, the *Ficus elastica*, the *Evonymus japonicus*, but it is only on this last tree and on the Citrus trees that it seems to grow and multiply itself to a dangerous degree. Of the Citrus trees the ones most subject to its attacks are firstly the lemon and secondly the citron and orange trees. The bitter orange is attacked less ; the most resisting is the mandarine tree ; for this reason whenever this disease has grown and assumed great dimensions many landlords devoted themselves to the multiplication of the mandarine tree or to the substitution by it of the destroyed lemon and orange trees.

When the disease has developed with intensity all the tender parts of the tree and even its big branches are covered by myriads of insects, which, impeding the regular respiration of the plant and absorbing a great portion of its nourishing saps, cause its quick exhaustion.

Of the tree thus attacked at first many leaves turn yellow and then little by little fall off. Afterwards its shoots and later on many of its branches are dried. In such a consumptive condition the Citrus trees and particularly the lemon tree may be preserved for many years, but they fructify very little or not at all.

Severe cold does not destroy the scales, as some have supposed, and this is proved by the fact that they grow even in the coldest climates. Nevertheless cold exceptionally severe for our climate may perceptibly contribute to the diminution of the number of these insects when they attack evergreen trees such as the Citrus tree, because when such cold occurs many leaves of these trees fall, carrying with them the *Coccidae* which particularly settle on them.

On the contrary, hot and dry weather greatly contribute to the multiplication of the scales and to the increase of the damage created by them.

The only atmospheric cause which effectually contributes to the restriction and sometimes to the disappearance of the scales of plants are continuous rains.

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(1) "On the *Coccinea*, and, particularly, the red scale of the Citrus Trees." Athens, 1880, and Annales de la Société Entomologique de France. Ser. 6ème T. 1, page 189 (1881). Synonyms : *Aonidia Gennadii Targ*, *Aonidia aurantii Mask*, *Aonidia Citri Kommstock.*

From a long time past it has been observed that the *Coccidae* are easily destroyed by water. Even the plants most completely attacked by these insects are freed from them by remaining 24-48 hours sunk in water (1), and exactly in order to protect them against rain, nature has endowed them with waterproof covers. Almost all the *Coccidae* secrete a substance more or less floury or waxy and sometimes limy, out of which there is generally formed over them a leathery cover, the *Scale*.

Nevertheless the *Coccidae* which are most exposed to prolonged rains cannot protect themselves for long by their scale. For this reason after a prolonged rain, carried by the wind towards a certain direction, we see the most wetted part of the diseased tree cleaner, bearing, comparatively, much fewer insects.

The measures recommended against the *Coccidae* are many, but the best of all is, undoubtedly, that successfully applied in California for the last nine years and which consists in the poisoning of the atmosphere which surrounds the diseased tree.

All those who keep hot-houses know the satisfactory results of burning in them sulphur and, particularly, tobacco, for destroying the *Coccidae* and the lice which very frequently grow on plants kept in hot-houses.

The application of this method in the open air was first attempted about thirty years ago by the American Hatch, when he obtained a patent (2). But until the year 1887 it did not come into use. About that time Wolfskill and Craw, from Los Angelos, published the satisfactory results, which, after a series of experiments, they obtained by the application of the aforesaid measure, which, having since been perfected, is now used throughout California and in some parts of Australia (3) especially attacked by the scales.

This measure consists in covering the tree attacked with a tent, under which are developed poisonous vapours, which quickly kills all the *Coccidae* on the plants as well as their eggs.

From this short description this method seems very simple, but in its use many difficulties present themselves, which only Americans possibly could have surmounted.

The entire covering of a tree of even moderate size by a tent would certainly prove difficult without special hoisting machines capable of being set up and removed from one place to another easily in a planted field. Without such machine the application of this method to diseased trees of great dimensions would have been impossible. It became therefore necessary to devise a special scaffolding, with or without wheels, carrying one or two folded tents.

The scaffolding is brought by the side of the tree to be treated; afterwards by the aid of pulleys the tent is opened out at the suitable point (according to the height of the tree) sufficiently to cover all the head of the tree and until the edge of the tent drops upon the surface of the ground.

(1) Boisduval mentions several instances of diseased plants which were cured by their having been sunk in water, and I have more than once cured such plants in flower pots, by having had them sunk in water for twenty-four hours.

(2) Report of the Commissioner of Agriculture, 1887, page 123.

(3) Destructive Insects of Victoria, 1891. Part 1, page 436.

Afterwards, under some point of the edge is introduced the substance which is to produce the poisonous vapours. But in order that the vapours may not escape from under the edge this is fastened down with earth.

For the same purpose, viz.: for preventing the escape of the poisonous vapours, and also in order that the tent may not be worn out too quickly, they make it of thick cloth and paint it with black oil-paint to which a little soap is added, this latter having the property of keeping the cloth comparatively soft and pliable.

A tent 26-30 feet high, with a circumference of 60-70 feet round the edge, is sufficiently spacious to cover even the largest of the Citrus trees usually to be met with. Such a tent, without the scaffolding, costs in California about 60 dollars.

Of the various substances made use of for poisoning the atmosphere under the tent the most usual and effectual is *potassium cyanide*.

Of this very poisonous substance use is made as follows :

In an earthenware pot, placed under the tent and by the trunk of the tree, are *first* put two parts of water, *secondly* one part of sulphuric acid, and *lastly* one part of potassium cyanide. Immediately after the addition of this last substance the man performing this work comes out of the tent and fastens down with earth the part of its edge out of which he came.

Out of the substances put into the pot an abundant gas of hydrocyanic acid is produced, which quickly fills the space under the tent and within half an hour at the most, kills all the scales which are on the treated tree.

This work must be done during the night because it has been observed that the vapour of hydrocyanic acid produced in the day not only does not bring about the desired effect but it also proves injurious to the tree under treatment, many shoots and leaves of which get destroyed, whilst the insects on it become only benumbed. This is attributed to the fact that light and the heat of the day decompose the gas of the hydrocyanic acid into other gases, which are injurious to plants but almost harmless to the scales.

By this means in 1892 only in the Orange county, in California, about 200,000 lemon and orange trees attacked by this very same scale were cured. According to Dr. I. H. Dunn, in one night and by one tent one can apply this method on about 200 trees up to eight feet high.

Pure potassium cyanide is expensive, consequently use is made of the uncleaned to be met with in commerce, which in America costs 26 cents per lb. But this has not always the same strength. This uncleaned substance contains 30 to 60 per cent. of pure potassium cyanide; so that before using it, it is indispensable that it should be analysed chemically, in order to ascertain the per centage of pure potassium cyanide contained in the uncleaned.

The quantity of pure potassium cyanide used for each tree depends on its size. The following table, which I take from one of the latest re-

ports on this subject by Riley (1), shews the quantities used of pure potassium cyanide, sulphuric acid and water, according to the size of the tree under treatment.

Height of tree.	Diameter of tree top.	Water.	Sulphuric acid.	Potassium cyanide.
Feet.	Feet.	Fluid oz.	Fluid oz.	Ounces.
6	4	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
8	6	2	1	1
10	8	$4\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{2}$
12	10	8	4	4
12	14	16	1	8
14	10	10	5	5
14	14	19	$9\frac{1}{2}$	
16	12	16	8	8
16	16	29	$14\frac{1}{2}$	$14\frac{1}{2}$
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33

This method although very perfect has the great defect for Eastern countries, as well as for Cyprus, of being exceedingly dangerous. The cyanate and all its compounds (2) are very strong poisons, and the use of such poisons, particularly when in an aerious state, is not right to be entrusted in the hands of our peasants. Among us such dangerous methods must only be applied by the authorities. Besides, on account of the dense planting and the irregular shaping, due to non-pruning of Citrus trees in Cyprus, the application there of the method in question becomes impossible without a copious pruning and sometimes cutting down some of the trees densely planted in gardens, in order that the scaffolding and the tent may be allowed to move and work freely.

For these reasons I am of opinion that in Cyprus may be continued the use of the emulsion made of water, soap and petroleum, trials of which had been made on the Citrus trees of the Island before my visit there, and that some other new emulsions should be tried the effectiveness of which is said to be much superior to that of the first.

Against the *Coccidae* and particularly against those which are covered by a leathery and waxy scale spraying by various substances more or less insecticide has long ago been tried. Of these the acids only in a thick solution become effectual ; but in such a condition they also attack the plants under treatment to a degree not permitting their use. Otherwise solutions of acids as well as most other liquid substances are not retained by the waxy covering of the insect and the tender parts of the plants, which is a serious drawback because many of the insecticide substances in order to prove effective must come in immediate contact with the scales and remain upon or by them for a long time.

(1) Report of the Secretary of Agriculture for 1891, page 265.
(2) Excepting the compounds of cyanate and iron.

This drawback is not presented by the dissolved alkaline substances, and especially by potash (for which reason it was formerly recommended after dew or rain to sprinkle the diseased trees with ashes); but they, even in a thick solution, kill comparatively few fully developed scales.

Imperfect also are the effects obtained against the scales even by a thick extract of tobacco, which has repeatedly been pointed out, as well as by many other well tried liquids, excepting petroleum and some other like substances, as well as the solution of soap, which have proved effectual and, from an economical point of view, capable of being applied.

Priority in pointing out the use of petroleum against insects in general is claimed by Americans and Italians (1). Use of this substance seems however to have been made for this purpose a long time before in France (2).

But the petroleum in a pure state, viz.: not thinned by mixing with it other substances, always proves injurious at least to the tender parts of plants, and, as it does not mix with water, endeavours were made to find out another substance by which to thin it. The property of thinning petroleum has been proved to be possessed by milk, common glue, caustic soda, resin and, especially, soap. By a solution of soap and petroleum an emulsion is prepared which does not separate and which afterwards, by the addition of water, is thinned more or less, according to the requirements of the case.

Sprayings with this emulsion are effective against scales when they are done repeatedly and at the proper seasons. The developed *Coccidae*, which are by this time covered by the scale, are not all killed even by the thickest emulsion, which, moreover, proves injurious to the tender parts of plants under treatment. Consequently, in order that the treatment may prove effective, it must be applied when the *Coccidae* are still young and before they are covered by the scale (3).

But the time and the duration of the presence of the young *Coccidae* vary according to the species they belong to and the earliness or lateness of spring in each district. Some species of *Coccidae* lay earlier and some later, whereas the multiplication of others begins from the first warm days of spring and goes on repeatedly very many times and irregularly until the end of spring.

To this last category belongs also the insect in question, which is covered with a resisting scale. Consequently for its extirpation the spraying with a petroleum emulsion must begin early in the spring and be repeated until the tree has become entirely clean.

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(1) Targioni Tozzetti. Cocceniglie degli agrumi in Italia. 1891, page 29.

(2) Insect Life, 1891-1892, Vol. 4, page 332.

(3) This has been proved by an experience of ten years and is confirmed by Marlatt, who says: "The various scale insects which have always been leading pests in sub-tropical regions, and are rapidly gaining importance also in the north, are, generally speaking, invulnerable to insecticide action in any strength which may be safely applied during the growing season after the covering scales are once well formed, and these insects can, therefore, only be successfully treated immediately after the young are disclosed." Insect Life, 1894-95, page 115.

The soap and petroleum wash is made in this way : in a boiler containing ten okes of boiling water four okes of soap are dissolved. When the soap has been well dissolved the boiler is taken off the fire and four okes of petroleum are added to the solution. This is added not all at once, but gradually, and the whole is well stirred during the adding and for about five minutes afterwards, when it forms a homageneous and non-separating thick liquid, which is the thick emulsion. When use has to be made of this it is dissolved by adding to it 90 okes more of water.

These proportions I have repeatedly tried with success against young *Coccidae* and without the slightest injury to the tender shoots or even to the flower of the trees under treatment.

Also without injury to the Citrus trees, use has been made in Italy of a wash containing petroleum or the heavy oils of pitch, 5-10 % (1).

In the United States, for Citrus and other trees having more delicate foliage, when attacked by scales, the use was pointed out of a wash consisting of five pounds of soap, five gallons of petroleum and thirty-five gallons of water, by the Special Commission for combating the *Coccidae*, which was held five years ago in the San Bernardino County (California). However, the Entomological Division of the Department of Agriculture in Washington recommends a preparation of thick wash made of two gallons of petroleum, half a pound of soap and a gallon of water. The wash thus prepared does not separate and is thinned with water when it has to be used (2).

The quality of the soap greatly contributes to the wash not separating. In the United States use is made of soap made of fish oil, but as we have no such soap here we must increase its dose, as I have already pointed out.

Moreover soap itself is insecticide, and, it has lately been proved, a thick solution of it alone may prove most effectual even against developed *Coccidae* bearing scales, without causing any serious injury to the tender parts of the trees under treatment. Exactly on account of the insecticide qualities of this substance, confirmed by repeated experiments, the Entomological Division of the Department of Agriculture in the United States warmly recommends now the use of a solution of 2 lbs. of soap in a gallon of water for destroying the *Coccidae* (3).

The soap is dissolved in boiling soft or rain water and the solution is used when it is cold, when, if the soap be of good quality, it does not produce any sediment, more or less solid or mucous, which would impede the use of this solution by the usual pulverisateur.

The thick solution of soap possesses also the great advantage that it can be used effectively at any season of the year, because, as is affirmed by all who have tried it, it kills even the fully developed *Coccidae* which are protected by scales. It is recommended to use it by preference in the autumn ; when the trees bear no fruit their foliage is somewhat thinner and on them are to be found the insects which will serve for the multiplication of the species in the following spring.

(1) Targioni Tozzetti. Cocceniglie degli agrumi in Italia. 1891, page 30.
(2) The San Jose Scale. Department of Agriculture, Washington, 1896, pages 57-58.
(3) The San Jose Scale, pages 62-63.

As an effective cure against the fully developed *Coccidae* they also consider Pitteleina, which I have already mentioned (1) and which is used in a solution consisting of two or three parts of Pitteleina and one hundred parts of water (2).

All these solutions are used with special pulverisateurs, the best of which are those made by Vermorel, which I found in use in Cyprus during my visit there.

But for the successful use of the solution, particularly with regard to evergreen trees, a good pruning is indispensable, in order that all the parts of the diseased tree may be abundantly washed. The leaves and branches obtained by the pruning must be immediately burnt.

As all other animals, so the *Coccidae* have their parasites. As I wrote on another occasion (3), sometimes the Icheumon flies greatly contribute to the restriction and sometimes to the entire extermination of the *Coccidae* in districts more or less extensive. But also numerous ladybirds (*Coccinella*) feed on the eggs of the *Coccidae*, not a little contribute to the prevention of their multiplication. L. O. Howard, the experienced entomologist of the Department of Agriculture in Washington, has been specially devoted for some years to the study of the parasites of the *Coccidae*.

Mal-di-Gomma. This disease was for the first time observed among the Citrus trees of the Azores Islands. From them it was imported into Portugal, where it attracted the attention of landowners since the year 1845. In France it was first observed in 1851 (4), in Spain in 1860 and in Sicily in 1862 (5).

From Western Europe the *mal-di-gomma* was spread to the East, having broken out with intensity in Poros for the first time in 1867 (6).

This disease I have found in Poros, Paros, Naxos, Andros, Carystos, Aegion, Patras, Gastouni, Tavla (Elis), Calamata, Messolonghi, Arta and lately in Cyprus, and from samples sent to me I have ascertained its presence in Chios, Crete and Jaffa.

In Cyprus the *mal-di-gomma* I met only on a few trees; nevertheless, on account of the great damage it inflicts when it spreads and develops itself with intensity, I have thought it necessary to record here in detail everything concerning it, in order that cultivators of Citrus trees may take at once the necessary precautionary measures against it.

The chief characteristics of the *mal-di-gomma* are the following: first of all the appearance on the fruit, the branches and, principally, on

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(1) Page 14

(2) Antonio Berlese.—Le cocciniglie degli agrumi in Italia. 1893, page 11.

(3) On the Coccidae. 1880, page 22.

(4) Bulletin du Ministère de l'Agriculture, 1891, page 452.

(5) Under the name of Gomma a disease of the Citrus trees in Southern Italy is mentioned before the year 1837 (Filippo Re. Nuovi elementi di agricoltura.—Milano, 1837, vol. 3, page 187), but it is not known whether it was the disease mentioned above, which only in 1862 broke out with intensity in Italy.

(6) As mentioned in the "*Helliniki Georgia*" of 1887 (page 282), a reliable landowner affirmed that in some of his gardens in Troezene the *mal-di-gomma* appeared since 1854. But was it really *mal-di-gomma*, or was it taken as such? It is certain that this disease showed itself for the first time with violence and greatly spread in our country only since the year 1867.

the trunk of the tree of a gummy, gluey, opaque and deep red tile-coloured substance. Secondly the paleness of the leaves and the tendency of the tree to push forth from all parts and out of season many small shoots and flowers, which betray a diseased condition and exhaustion in all fruit-bearing trees. The tree when attacked withers little by little and its fruit sometimes splits, and at last the tree itself is either dried up or else it is uprooted by the cultivator as altogether worthless.

The presence of gum is the surest indication of the disease. This shows itself usually at the base of the trunk in the form of one or more spots, which have at first the diameter of a shilling or even a greater one (according to the progress of the disease), and of a deep, brilliant colour. The spot, looked at closely, if it is spring or autumn or if it had rained a few hours before, seems to consist of a damp and gummy substance, which much resembles boiled but cooled down glue, and if it is summer or a dry winter day, we notice that the spot is formed of a stratum of a glassy, hard substance representing a plate, usually circular, adhering to the surface of the bark. Often, however, and especially when the disease is somewhat advanced, the gum comes out of the trunk and the branches, concentrates, and takes the shape of more or less regular globules. If we examine with attention the point from which the gum comes out, we discover a pore or split, which, in proportion as the disease advances, grows, and the bark around it is raised up and becomes hard and brittle, and the wood under it loses its natural colour and becomes dry and hard. The evil usually confines itself to the circumference of the base of the tree, when it very quickly causes it to dry, because the bark and the first stratum of the wood under it being destroyed all round, the circulation of the sap is altogether arrested. It sometimes happens, however, that only one side of the trunk is attacked, the chinks taking an upward direction. In such a case the tree is capable of resisting more. When, however, the chinks proceed downwards, which is rarer, or when they appear on the roots, then the tree may be dried even within the first year of the attack.

In this last case, the disease developing itself underground, its chief symptom, viz.: the secretion of the gum, remains concealed under the earth, where the roots becoming rotten with surprising rapidity, stink and are destroyed before the secretion of gum from the trunk and the branches has begun. This case has induced many at first to suppose that not one but two diseases, distinguished from one another, are those which for many years past mortally attack the citrus trees, viz.: the *Mal-di-gomma* and the decomposition of the roots. However, more exact observations proved that there is only one disease, which is of a mild form whenever the roots of the tree are attacked last, and malignant whenever they are attacked the first. The mild or the intense development of this disease depends on the nature of the soil, the humidity of the atmosphere and the abundance of manure supplied. Externally Citrus trees when they have only their roots attacked are distinguished by the paleness of their foliage, by the great number and weakness of the shoots, by the smallness (1) and the splitting of their fruit and by

(1) Webber (Year Book of the U.S. Department of Agriculture, 1894, page 200), describing a sort of *Mal-di-gomma*, the die-back, attacking the orange trees of the United States, says that the fruit of the trees moderately affected by it grows larger than usual, but is coarser and has very thick and rough rind.

their quick weakening and falling. The tree thus attacked soon loses most of its leaves, and as most of its roots are rotten it is easily detached from the ground. The soil around the roots being dug up, an intense stench is exhaled from the rotten roots. The wood of such trees, when dried, becomes very hard, because it is full of gum.

These are the symptoms by which one can easily detect the disease in question, the origin of which has not as yet been sufficiently ascertained. To find this out it was necessary to ascertain before the way in which gum is formed in the plants. To this object many have devoted themselves, amongst them Prilleux (1), who has also recapitulated all the researches made by others before him. All these admit that the gum is the product of the decomposition of vegetable tissues.

But there are plants which yield abundant gum without any disagreeable consequences with regard to their further regular and healthy growth (2), whilst the presence of this substance in other plants, and particularly in the Citrus trees and the Amygdaleae, is generally the forerunner of their death.

Some have maintained that the *Mal-di-gomma* of these trees is not contagious (3), and others have held that this disease of the citrus trees is the result of their degeneration. But if these opinions, at least with regard to the Citrus trees, were exact, the disease would not have taken a regular direction from the West to the East, but would visit those countries in which the cultivation of these trees is more developed and is carried on extensively from time immemorial ; and it would not be transmitted from one tree to another and from one garden to another, as it generally happens, but would attack at the same time almost all the trees of a garden or a district where they are cultivated for centuries. Besides the contagiousness of the *Mal-di-gomma* of the Citrus trees has been proved by long experience. For this reason experienced and diligent cultivators isolate the tree attacked by *Mal-di-gomma*, digging around it a ditch, in order to prevent the spread of the disease by its roots to the adjacent healthy trees ; and when the tree has been dried up no other tree is planted in its place for some time, during which the hollow out of which the dead tree has been removed remains open, in order to be aired, and the soil around it is disinfected by adding and mixing with it ashes or lime.

These facts prove, I think, that the *Mal-di-gomma* is not an organic disease, viz.: it does not proceed from the supposed exhaustion or degeneration of the tree, but it is contagious. Everybody now admits that the cause of contagious diseases (of plants and animals) is micro-organisms, sometimes difficult to discern even by the most perfect optical instruments.

The existence of such micro-organisms in the gum of several fruit-bearing trees was noticed some years ago by scientific men. Thus Briosi observed in the gum of Citrus trees a fungus which he classed

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(1) Sur la formation de la gomme dans les arbres fruitiers. An. des Sciences Naturelles, 6 série, vol. 1, page 176.

(2) "*Helliniki Georgia*" of 1889, page 523, and of 1893, page 355.

(3) "*Helliniki Georgia*" of 1889, page 565, and of 1890, page 330.

under the genus of *Fusisporium* (*F. limoni Br*). He states that it is very small in size and that it grows with surprising rapidity (1) The Dutchman, Beijerinck, after many researches, asserted that the gum of fruit-bearing trees is caused by a certain fungus (which Udmann classed under the family of *Ascomycetes* and named *Coryneum Beijerinkii*— or according to others, *Pleospora gummipara*), and that if transferred to sound trees of the same species quickly transmits the disease to them. He also observed that the gum of some trees is easily inocculated, not only on those of the same species but also on those of the same genus. In this way the gum of the peach tree he communicated to the plum tree and that of the cherry to the apricot tree (2). But exceedingly important are the most detailed observations regarding, particularly, the contagious nature of certain diseases of plants, made by T. J. Burrill, Professor of the Illinois University at Champaign, (Illinois, U.S.), and by Comes, Professor at the Agricultural School of Portici, in Italy. Burrill, for a long time past occupied with the study of the blight of the pear and apple trees and of the yellows of peach trees, has confirmed (3) the existence of bacteria in the diseased parts of these trees, and by inocculation he has proved their contagious nature (4). After Burrill, Comes, in endeavouring to find the cause of the yellows of fruit trees and the gum of Citrus trees, discovered on their diseased parts a multitute of bacteria (*Bacterium gummi*). In order to ascertain their contagious nature he inocculated them on healthy roots, which in a few days were attacked by the gum, having broken out exactly at the point where the inocculation took place (5).

This is what may be said here with regard to the cause of this disease, to the growth and intensity of which certainly contribute also the condition of the atmosphere and the quality of the soil, of which we shall say a few words hereafter. We shall now examine which are the most effective means for the prevention and cure of this disease.

Italy produces annually about 500,000,000 kilogrammes of Citrus fruit, of which more than three-fifths are the product of Sicily. These numbers show the importance which the production of Citrus fruits possesses in Sicily and explains the fear created there since 1862, when the destructive gum appeared in their gardens.

For many years in succession this disease dried up the Citrus trees without either science or experience having been able to accomplish anything towards the restriction of the evil. Since the year 1874, the Italian Ministry of Agriculture, to excite emulation and encourage researches, proclaimed a competition and fixed a reward of fr. 25,000 in favour of him who would suggest a remedy which might be easy to use, effective and not costly, for the treatment of Citrus trees attacked by the

(1) Intorno al mal di gomma degli agrumi, Giovani Briosi, Roma, 1878, page 9.

(2) Revue horticole, 16 Novembre, 1885.

(3) Transactions of the Ills. State Horticultural Society, 1879, page 79.

(4) Bacteria as a cause of disease in plants. From the American Naturalist, July, 1881.
The bacteria. Their nature and effects (1882). By T. J. Burrill, Professor of Horticulture at the Illinois Industrial University.

(5) O. Comes. Marciume delle radici nelle piande fruttifere. Milano, 1885.

gum. It also appointed a Commission of professional men for examining the remedies proposed. No such remedy, however, has up to this day been found.

Very numerous have been the measures hitherto proposed for treating the gum-diseased Citrus trees, but all have proved ineffectual. Various disinfectants, caustic substances, special manures and even cauterisation (1), proposed by Savastano, have been repeatedly tried without any practical result. The Citrus trees attacked by the gum are, as a general rule, condemned to die—their death is only a question of time. When the disease is developed at the roots the tree attacked is quickly dried, but when the attack begins from the trunk or the branches its life may be prolonged for some years if irrigations are restricted and the organic manures are substituted by inorganic ones and by amendments, such as ashes, lime, sand (of which use is made if the soil is very clayey). Besides an excellent means for the prolongation of the life of diseased Citrus trees is the digging about them, in order to air the soil near the roots, as well as by taking off by sharp implements the diseased parts of the tree (roots, branches and trunk). The naked parts of the wounds thus occasioned must be anointed with soft clay mixed with a little iron sulphate and a larger quantity of ox-dung in a state of ointment.

But if we cannot cure the Citrus trees attacked by the gum, nevertheless, we have at our disposal a means by which we can prevent the destructive development of this disease in new plantations; and that is developing by sowing bitter orange trees, and then grafting on them the other species and varieties of Citrus trees which we propose to cultivate.

As a general rule the varieties of cultivated plants are more sensitive to the attacks of extreme atmospheric changes and of various diseases than those of the same species which grow wild. It has, moreover, been observed that of almost every cultivated tree there is a species, which, although producing less and inferior fruit, is, nevertheless, more resisting and lasts longer. This more robust species may be considered as the original type of the cultivated variety, which gardeners amongst us, recognizing this principle, usually call *wild*, and utilize it for grafting the choicer but feebler varieties.

The *type*, therefore, of the Citrus trees is the bitter orange, which in comparison to the other Citrus trees has a longer life and is more resisting; and on it are grafted all the other species and varieties of Citrus (2). Its only defect is that its development is comparatively slow. But this is an insignificant matter in view of the advantage it possesses of resisting the attacks of gum.

For many years past it has been observed that while all the other species of the Citrus tree when attacked by gum are destroyed, the bitter orange not only is seldom attacked by this disease, but even, when attacked, it resists generally. On account of this, Citrus orchards are now

(1) Della cura della gomma e caric degli agrumi. Napoli. 1887.

(2) Of the Citrus, the most subject to the attacks of the gum and of other diseases is the lemon, and, secondly, the cedrat tree. The bitter orange is the most resisting: it is very seldom attacked by the gum. The mandarine tree is also seldom attacked by this disease. Nevertheless, lemon trees grafted on orange trees maintain in any case their delicate nature.

planted with bitter orange trees, and every provident cultivator of Citrus trees generally reserves in a corner of his property a nursery of bitter orange trees, which he utilizes for the substitution of trees destroyed by age, gum or other cause. The keeping up of such nurseries becomes indispensible, particularly to cultivators of Citrus trees in countries where on account of the Phylloxera the importation of trees is prohibited.

These nurseries are usually made in a southern corner of the estate and their space is proportionate to the number of trees required. One can grow many dozen bitter orange trees over a surface of about ten square metres. The preparation of this tract consists in digging it deep during the month of January, abundant manuring, levelling the ground and sub-dividing it into garden beds. In order that the wild weeds growing on it may be destroyed and the soil triturated and aired sufficiently, this tract is dug up a second time a few days before sowing, which takes place in March or April as follows:

In order that the germinating power of the seeds of bitter orange trees may be preserved, they are taken from ripe and robust fruit two or three days before sowing, and having been well washed with water and dried by being spread out in a dry and shady place, they are sown in one of the prepared tracts and then covered with a mixture consisting of equal parts of sand and manure, of goats' by preference, and at last they are abundantly sprinkled with water. The watering is repeated throughout the first year after sowing whenever it becomes necessary. When the seedlings yield three or four leaves they are thinned, by rejecting those which are weak or which grow very densely. From that time the weeding begins, which is often repeated until the replanting of the seedlings.

This work is done one or two years after sowing, when the seedlings are replanted in the ready tracts close by and in distances of about 20—30 centimetres from one another. For facility's sake some of the seedlings, usually the weakest, are allowed to remain in their original places. When the replanted bitter orange trees rise above a metre, the grafting begins. This is done by inocculation and at a height of 70—80 centimetres from the surface of the ground. These plants may be replanted in their definite places a year after grafting.

In multiplying the Citrus trees by this means attention must particularly be paid to the selection of the grafts which must proceed from a tree healthy and perfect in every respect, and to the selection of the seed, which, as I have already said, must be taken from ripe and robust trees. These fruits may be kept on the trees in an excellent condition until sowing time. But even when cut off they can be kept in good condition for a long time in a well ventilated store. It is also indispensable that the grafting should not be lower that 70 centimetres; because it has been observed that when trees are grafted high they are more rarely attacked by gum. At last we must remark that for replanting, pruning and grafting new plants it is necessary to use special implements for the purpose or such as can be cleaned and disinfected in a solution of lime or carbolic acid; because, as we have seen, the disease is contagious and may be easily communicated to young plants, if the implements employed for their treatment had been used for the cultivation of diseased trees.

But even lemon trees grafted on bitter orange at certain seasons and in some soils are sometimes attacked by gum, and the effect of this attack may prove fatal. Thus, for instance, it has often been observed that such trees, when cultivated in soils naturally damp, during rainy years may be attacked by gum and may die.

When attacked by gum these trees must be subjected to a special cultivation, which consists in a limited watering, in the use of a small quantity of well decomposed organic manures, in the substitution of these, as much as possible, by inorganic manures and amendments, such as ashes, lime and sulphate of iron, in the frequent digging of the soil, in the ventilation of the roots by considerable digging during the spring, in the draining of the ground which may be damp, by digging up ditches and in the early removal, during the spring, of the dry branches or attacked parts of the bark.

Ashes are an excellent manure. They contain exactly those substances which, as has been observed, the wood of Citrus trees attacked by gum contain insufficiently. Ashes also serve as an antiparasitical substance. Lime also serves as an antiparasitical substance, being also an amendment. These properties has also the sulphate of iron.

Of these substances use is made during the spring in the following way: the diseased tree is well dug round, and the ashes, the lime and the sulphate of iron are put in a state of powder on its exposed roots; it is afterwards watered once and left uncovered for ten to fifteen days. The quantity of these substances used is, of course, proportionate to the age of the trees treated. For a bitter orange tree ten years old we use about five okes of lime or two okes of sulphate of iron. Ashes one may use up to ten okes for each tree. But this substance is not always handy, and, consequently, cultivators must of necessity resort to the use of lime or of sulphate of iron, which are more handy and more effective against parasites.

The removal of the dry and gourmand branches is done by a well-cutting secateur, and the parts of the trunk and branches which are attacked by gum are taken off by a knife or some other sharp implement. The wounds thus occasioned are anointed over either simply with common clay or still better by a mixture of clay, ox-dung and finely ground sulphate of iron.

But of all these the principal operation is digging round the trees during the spring and putting the above-mentioned substances at the roots. Dumas was the first who suggested the digging, and instead of the aforesaid substances, he proposed the use of sulphur. The digging round was subsequently successfully applied against the gum disease by De Noveli (Annali di Agricoltura Siciliana), and afterwards by Di Georgio and by Della Fonte ("Italia Agricola," 1883), and Comes, who, by repeated experiments, showed the great importance of this work and of the use of the caustic substances for the prevention of the spread of the gum disease (1).

It is, of course, unnecessary to say that in carrying out this digging all the rotten roots and the diseased parts which may be met with must

(1) Marciume delle radici nelle piante fruttiffere, 1885. And Delle principali malatie delle piante coltivate nella Sicilia, 1885.

be taken off. The timely application of these measures saves lemon trees grafted on bitter orange trees which are attacked by the gum.

Diseases of Olive Trees. The principal diseases of olive trees, which I have personally observed or which have been pointed out to me during my visit in Cyprus, are the *Tinea oleella, Fab., the Dacus Oleae* and the *Tumours*. Of the *Psylla* mention was made to me only in Evdhimou, where few olive trees exist, but as this disease is also one of the most injurious to the olive tree I shall give a description of it as well.

Tinea oleella. Of the many parasites which attack the olive tree the most dangerous, being the most difficult to get rid of, is the *Tinea oleella*, a microlepidoperous insect, belonging to the family of the *Tineidae*.

This insect, known also to the ancients (1), makes its appearance at three different periods of the year, attacking each time different parts of the olive tree, viz.: it has three generations (*a*), that which attacks the leaves and the new shoots, (*b*) that which attacks the flower, and (*c*) that which attacks the fruit.

On account of the appearance of this insect at different times of the year and the development of its three forms on different parts of the olive tree, it was for a long time supposed that three different insects (2) inflicted these injuries, but, thanks to the exhaustive observations of many scientists, we now know that these injuries are due only to the *Tinea oleella*, the life of which is summed up as follows.

If during the winter we examine with attention the leaves of the olive tree the fruit of which at the last gathering time fell before maturity, we distinguish scattered over their lower surface the very small, spherical and milk coloured little eggs of the *Tinea oleella*.

About the beginning or the middle of February out of these eggs proceed some very small worms, which cutting the skin of the lower surface of the leaf eat up its parenchyma. The leaves thus attacked bearing more or less transparent sinuous lines or irregular spots, are distinguished from a distance and get partially dried, but they seldom fall. When the worm has been fully fed, it is hairy and is 7—8 millimetres long (Fig. 1). Its colour is brown, turning towards the green, excepting the head which is reddish, the neck which has on the top two black spots, and the back, along which there are two black lines. The worm comes out of the leaf by piercing always its lower surface, on which—or on the lower of another leaf—weaves a cocoon, within which it is enclosed in order to undergo its transformations just as the silk-worm does (Fig. 2).

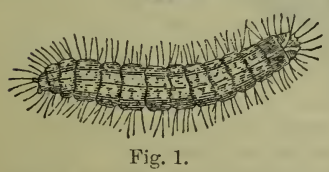

Fig. 1.

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(1) Theaphrastus. Hist. Plants. 4, 14, 9 and 4, 14, 10.
(2) *Elachista oleella, Cynips oleae* and *Oecophora olivella.*

So long as the worms of this generation content themselves with feeding on the parenchyma, the injury done is very little. But it often occurs that many of them come out of the eggs later than usual when new and tender shoots are present, which they attack by preference by eating the ends of the leaves (Fig. 3) and *piercing them exactly at the insertion of the shoot on the old branch.* In some varieties of olive trees the holes thus produced are quickly healed; in others, however, they remain open and when it rains they are filled with water. This causes the destruction of the axis of the shoots, which in the following autumn get dry and break by the wind. Sometimes the shoots thus attacked dry immediately after the attack, viz.: in the month of March, as we happened to observe in the year 1893 in the olive grove of Volo, in 1885 in the plain of Argolis and in 1890 near Athens. This attack of the shoots many times takes serious dimensions, when the injury becomes considerable. Such an attack I observed in the year 1892 in most of the olive groves all along the railway line between Corinth and Aegion.

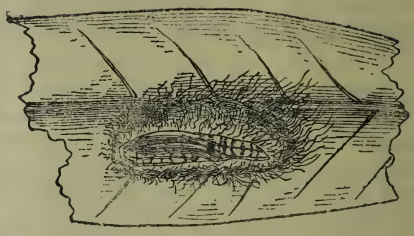

Fig. 2

An olive leaf four times magnified, and bearing a cocoon of the *Tinea oleella.*

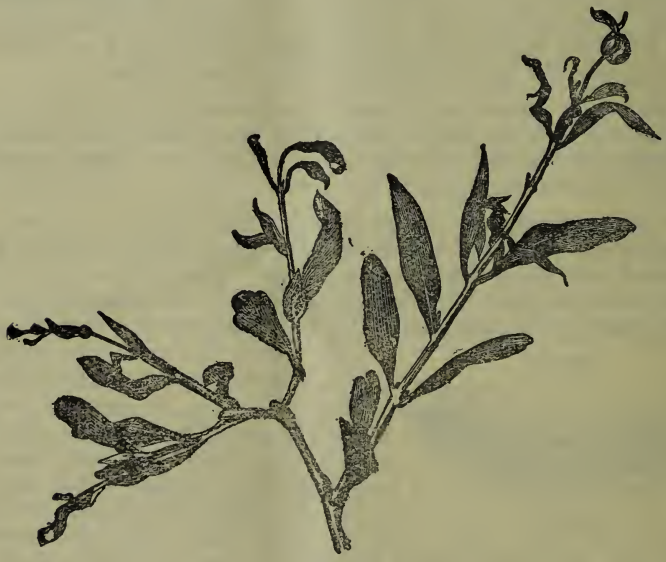

Fig. 3.

At the end of the month of March or the beginning of April the chrysalis of the *Tinea oleella*, which is enclosed in the cocoon is transformed into a moth. It is about a centimetre long and bears four greyish fringed wings ornated with black spots. (Fig. 4 a).

These moths live for about a month, during which they copulate. During the day they keep quiet, concealed under the leaves; from sunset they fly round about the olive tree and deposit their eggs on its most tender shoots about the middle or the end of the month of April. This is the first generation of the *Tinea*.

The eggs deposited by this generation are hatched about the beginning or the middle of May, and the worms coming out attack immediately the flowers of the olive tree, which by this time open, often decimating in this way the crop. About the middle of June they weave, as has been described, their cocoons, in which they are transformed into chrysalides, and in 7 or 8 days they assume the perfect form of the insect—that of the moth—and come out of the cocoons. After living in this form for about a month, viz.: about the end of June or the beginning of July, by which time the fruit of the olive tree is formed, the females deposit on each of the yet small olives, and by their pedicel, one egg. In this way finishes the period of the second generation of the *Tinea*, which may be considered as the most destructive, because, according to the observations of Costa, each worm of this generation destroys on an average twenty flowers.

Fig. 4.

The little egg, deposited on the small olive, is hatched ten days afterwards, and the worm coming out of it and piercing the flesh of the fruit as well as the kernel, which is still soft, enters into it and begins feeding on the cotyledons enclosed therein. The small hole opened by the pedicel of the olive is quickly healed and every external trace of it disappears. (Fig. 4 b, c.)

The worm thus enclosed within the kernel finds in the cotyledons food sufficient for its maintenance and development. When it reaches the end of its growth, viz.: about the end of August or the beginning of September, it must come out of the kernel in order to undergo its transformation. But at this time the kernel is on all sides woody and, as is known, very hard, excepting the point at its base, which by botanists is called *micropyle*. Consequently, the worm finding this point easily pierces it and comes out by the pedicel of the fruit, which it immediately leaves in order to find a proper place where to weave the cocoon and undergo its transformation into a chrysalis. It chooses the proper place either by the pedicel of the fruit itself or on adjacent branches and leaves, which it reaches by being suspended from the abundant fruit by a fine silky thread (Fig. 5), or, lastly, amongst the leaves under the trees on which it may fall in its descent by the thread.

Eight or ten days after the transformation of the worms into chrysalides, viz.: about the beginning or the middle of the month of September, the moths of the third generation make their appearance. These, after

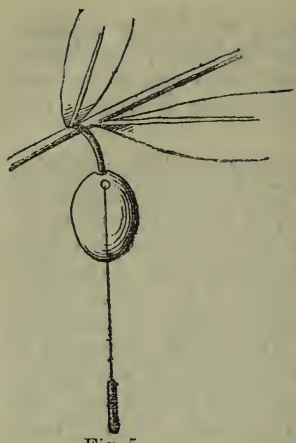

Fig. 5.

copulation (about the middle or the end of October) deposit their little eggs on the lower surface of the leaves of the tree on which they hibernate. In this way the annual evolution of the life of the *Tinea* is completed.

These eggs, as we have seen, are hatched in the following February, when a new evolution of the insect begins.

The worms of the third generation coming out of the olives in which they have been living, pierce, as we have remarked, the fruit by the pedicel and destroy the fibres which connect it with the kernel. This renders difficult the holding on the trees of the otherwise enfeebled olives; and they, shaken even by the slightest wind, fall to the ground as yet unripe. These olives, when pressed, yield good oil but little in quantity. Many times the attacked olives in consequence of violent winds fall to the ground even long before the worm of the *Tinea* abandons them, in which case the yield of oil is very small.

The injuries inflicted by this insect during its three generations are often considerable, but those of the second generation are indisputably the greatest, although most people do not discern them, as they are inflicted during the flowering, when the estimate of the crop is not the work of everybody. From this circumstance it often happens that whilst great production of olives is expected, the crop turns out very poor, although no other circumstances seem to justify such a result.

This detailed description of the life of this *Tinea* was indispensable in order that olive-growers on the one hand may understand the magnitude of the injury, which this insect, under atmospheric circumstances favourable to its multiplication, may bring about if left undisturbed, and on the other, that they may convince themselves that for combating this enemy of the olive tree they must spare neither trouble nor expense.

Measures against destructive insects prove more difficult in proportion to their easy multiplication and numerous breedings within the same year. This is exactly the case with the *Tinea*, which not only appears several times during the year, but also feeds on almost every part of the olive tree. This variety in its food and in its many generations render necessary the use of various measures against this small but very injurious insect.

First of all, during the months of February and March, as many of the diseased leaves of the *Tinea* as is possible must be taken off and burnt. These leaves are easily distinguished, because, as we said, they bear one or more spots almost transparent, which then look whitish from a distance, and which are the signs of the place where the worm of the first generation has been fed. This work is certainly laborious, and, superficially examined, seems inapplicable and ineffective; nevertheless, it is most effective and advantageous, because, *if we take into*

consideration that during gathering time it is of advantage to collect the olives one by one, we shall understand that it is of still greater advantage to gather one by one the diseased leaves; since, as is known, each of them as a rule contains a worm, out of which, only a few days afterwards, there will be produced at least (taking into consideration the breedings of the insects and their diminution by various circumstances) ten other worms of the second generation, each of which, as we have seen, destroys twenty flowers, viz. : twenty olives.

It is, besides, necessary to gather quickly the olives which fall prematurely, many of which may still contain the worm of the third generation, and in August and September to shake the branches of the trees in order that the diseased olives, which at this period are easily detached from their pedicels, may fall. *All this fruit must be pressed immediately in order that enclosed worms may be destroyed before their transformation.*

Moreover, it is often necessary in the months of April, June and September, during calm evenings and an hour after sunset, to light fires within the olive groves, by which the moths of the *Tinea* as well as other crepuscular insects are attracted and burnt. In order to burn as many of them as possible, it is necessary, whilst the fires are lighted, to shake the branches of the olive trees close by, so that the insects which may be resting on these trees may be driven to the fires. This method, often tried, has proved effective and comparatively cheap, but in its application great care must be taken to avoid the spread of the fire. The destruction of the moths of the *Tinea*, and of other similar insects is also accomplished by the following more expensive but more sure and effectual method. During the aforesaid months and hour in different parts of the olive grove and on eminences (on trees for instance) are put wooden cases anointed inside with a gluey substance, such as resin or tar. Within these cases a lantern is put, emitting a pretty strong flame, and in order that this may throw its light far, in the case a stool is put on which the lantern is placed. The moths, attracted in hundreds by the light, stick on the inside of the case and die. The cases must be anointed repeatedly that the ointment may be kept fresh and, consequently, gluey.

Besides these means, generally admitted as effectual, Décaux [1] proposes also the following : (*a*) frequent shallow ploughings under the olive trees ; (*b*) the spread of soot under them, and (*c*) manuring with rags soaked in petroleum. These means are undoubtedly very good against the *Dacus Oleae*, which, as we shall see lower down, hibernates, as a rule, in the ground in the form of pupa. But, as we have seen, very few *Tineae* come in any way in contact with the ground.

The treatment by spraying, advised by Berlese [2] we find objectionable from an economical point of view, because the revenue from the olive trees does not permit such expenses as the effectual application of the spraying would require. Besides on account of the dimensions which olive trees generally reach in the East and on account of their not being regularly shaped by pruning, the perfect spraying of these trees would be most expensive if not impracticable.

(1) Revue des sciences naturelles appliquées. Août 1892, page 128.
(2) L' agricoltura e le industrie agrarie. 1893, page 123.

Consequently, both from an economical and practical point of view the only applicable means are those described above in detail, and particularly *the timely gathering and burning of the diseased leaves and also the timely gathering and pressing of diseased fruit.* Those who make up their minds to use these means even isolatedly, will free their olive plantations from the attacks of the *Tinea*, or will, at least, reduce considerably the injuries produced by it. Those who do nothing for the prevention of this injury abandon themselves to fate, which may sometimes show itself kind to them. Indeed, special atmospheric circumstances, and particularly some special parasites of *Tinea*, appearing sometimes in certain places, contribute to its diminution, or even to its complete, apparently, disappearance.

Dacus Oleae. Meig. Equally injurious to olives, but more attackable than the *Tinea*, is the *Dacus*, commonly called *Olive worm.* This worm and the injuries inflicted by it were also known to the ancients, who, however, confounded this worm and that of the *Tinea* (1). This confusion is, as a rule, made even to-day by our peasants.

The *Dacus* of the olive tree is an insect belonging to the order of the *Dipterous* and to the family of *Muscidae.* On the whole it resembles the common fly, but it is a little smaller, and has the abdomen rather spherical (Fig. 6). Its eyes are rather green, and on the forehead of its yellowish head it bears two black spots and two antennae, from the base of each of which grows a hair longer than they. Its thorax is ash-coloured and has all along at the top four yellowish lines. Its legs and feet are yellowish, and its wings transparent and irisated. Its abdomen is black and has at the top a central broad yellow line. The cylindrical worm, little longer than the perfect insect (6 m. m.) (Fig. 7), is of white colour turning towards yellow; it is soft, footless and has at the mouth a pair of black pincers, by which it cuts the flesh of the olive.

Fig. 6

The small figure represents the natural size of the fly.

Fig. 7.

The small figure represents the natural size of the worm.

The pupa is a little smaller than the perfect insect (4 m. m.) (Fig. 8); it is long and oval in shape and whitish in colour, and it is covered by the hardened skin of the worm.

Fig. 8.

The small figure represents the natural size of the pupa.

Anybody can easily examine in detail these three forms of this insect by cutting up worm-eaten olives or by keeping some of them for some days in a box, or, better, under a glass.

The *Dacus* in its perfect form appears in multitude at the time the fruit of the olive tree is attaining its greatest development, viz.: about the end of the month of July. A few days after the appearance of these

(1) Theophrastos. Hist. Plant. 4, 14, 10 and Causis Plant. 5, 10, 1.

flies the females are fecundated, after which they go to the fruit in order to deposit their eggs. For this purpose they choose by preference those which are nearest maturity. Every female lays about 300 eggs and, as a rule, she deposits on each fruit only one, after having ascertained by a careful enquiry that that particular fruit does not already bear the egg of another *Dacus*. This instinctive providence of the insect has the object that the young on coming out of the egg may find abundant food not disputed by another worm. Nevertheless one may sometimes find olives containing two or even three worms, but this happens for the most part when the crop is scarce and the egg-laying insects are many.

For depositing the eggs the *Dacus* prefers calm and warm places as well as those parts of the trees which are most exposed to the sun. It has, moreover, been observed that the fruit of the very productive and robust trees is less subject to the attacks of this insect.

Fig. 9.

Ten or fifteen days after having been laid the egg is hatched and out of it a very small whitish worm comes out, which for 15, 20 or 15 days (according to the higher or lower temperature of the atmosphere) feeds by eating up the flesh of the olive. By the end of this period the presence of this in the fruit is externally most obvious from a spot which has the surface somewhat hollow and black if the olive is still green, and of a lighter colour if the olive is more or less ripe. (Fig. 9).

When the worm has been well fed and has acquired its full development, in order to transform itself it approaches the skin of the fruit. Some of the worms are transformed under the skin of the olive, but most of them break through it and let themselves fall to the ground or near the dry leaves at the base of the trunk of the tree, where they undergo their transformation into the pupa state. During this process the skin of the worm shrinks and hardens and its body becomes shorter and takes an oval shape (Fig. 8). In this form the insect remains inactive usually for a month, after which time it transforms itself into the form of a fly and, breaking through the skin which encloses it, comes out.

From what we have said it results that the life of this insect, from the depositing of its egg to the appearance of the fly, lasts 50 to 70 days.

This length of time may be restricted to 40 days only, as often happens in warmer climates, when we have two breeds during the same year (1). But the life of *Dacus* may be prolonged for several months, which happens (*a*) in colder countries, where for the most part only one breed presents itself ; (*b*) in the warmer ones, where the insects of the last breed hibernate in the form of flies in the hollows of the trunks of old olive trees and in the form of pupa in the ground, in the stores (where, before pressing, the fruit is stored up), and on the unripe olives which may be left on the trees after gathering and which sometimes remains on them until the following spring.

In the form of fly the *Dacus* usually continues for 20—30 days, during which he lives sucking by his proboscis the sap and the gummy substances, which many trees and the olive tree itself yield through their leaves and branches. Nevertheless, as we have said above, sometimes the *Dacus* in his complete form lives for several months, hibernating in the cavities of the trunks of old trees.

The injuries inflicted by this insect are sometimes very considerable. Most of the olives which are attacked early become atropliced, get dry and fall before they ripen. When the olive tree is attacked by one worm only it loses about the fourth part of its oily substance ; but, as we have seen, sometimes each olive may contain two or three worms, a circumstance, which, if at all general, may reduce the yield of oil by half.

But the injury occasioned by the ravages of the *Dacus* is not confined to the quantity of the product ; it extends itself even to the quality, because worm-eaten olives become unsuitable for eating, and the part of their flesh which is attacked becomes furfuraceous, contains foreign organic substances (spoils of the insect) and acquires a disagreeable taste, which is quickly communicated to the remaining sound flesh. On account of this very reason the oil produced from worm-eaten olives is more or less rancid, unsuitable for eating and sometimes even for burning.

To prevent these injuries several means have been proposed, the most effectual of which are the following.

Early gathering, and the immediately after it grinding, of the fruit is indisputably the best measure, as it is inexpensive and effectual. By it the full development of the insects which attack the olives, and, consequently, the depositing of their eggs as well as the further destruction of the flesh of the fruit, are prevented ; and at the same time a yield of more and choicer oil is obtained. This last fact has been proved by the experiments of Guérin-Méneville, who suggested this measure in 1847.

From a diseased olive grove he obtained 25 % oil of good quality from olives gathered during the second fortnight of September, whilst from olives gathered out of the same olive grove, during the first fortnight of October, he got 18 % of oil of middling quality ; and from olives gathered during and after the second fortnight of the same month he got only 15 % of oil, and this of very bad quality. Since then the

(1) Sometimes even four, as is stated in the "Bollettino di notizie agrarie," 1894, page 367.

trial has been repeated by many; and it has always been proved that olives attacked by the *Dacus*, if gathered and ground earlier than usual (even before their full maturity) yield much more and choicer oil.

But, besides this advantage, the early gathering of olives has also the following, mentioned by Décaux (1).

Long experience has proved that olives which for some reason or other are early disburdened of their fruit, in the following year, instead of requiring rest as it often happens, bear again flowers and fruit. This is, besides, observed in all parts where, on account of the climate or of custom, the gathering of olives terminates within the month of October. In those parts (as, for instance, in the surroundings of Aix), olive trees yield a more or less full crop almost every year.

Taking into consideration all these results of long experience, olive growers must hasten to gather and grind their fruit in order that they may compel the tree to produce almost every year and that they may be free from the serious injuries very often inflicted by the *Dacus*, or at least that they may restrict them considerably.

But to successfully combat this scourge the following measure must also be applied, which contributes, moreover, to the sounder development of olive trees. We have already seen that the worms of the last generation of the *Dacus* fall to the ground, into which they enter and where they are transformed into the pupa state and pass the winter. So immediately after the gathering of the fruit, or early in the spring, the land under the olive trees must be ploughed or hoed shallow to the base of the trunks of the trees, in order that the *Dacus* which hibernates a few centimetres under the surface of the ground, coming to the surface by the turning of the soil, may be destroyed by being dried up or by being eaten by birds or ants. This process becomes still more effective if, before the first turning of the soil, there be spread under the olive trees a mixture of twenty okes of ashes and ten okes of lime per stremme as well as about ten okes of rags (woollen by preference) divided into small pieces and soaked in two okes of petroleum (2). These substances serve also as insecticide and as an excellent manure to olive trees.

We have said that of olives stored, many bear yet the insect in a state of worm or pupa. The heat produced in the store by the fermentation of the olives accelerates the transformation of some of them. In this case the pupa transform themselves into flies, which, as a general rule, fly out of the store (3). But the worms which come out of the olives find suitable places where they are transformed into pupas. These hibernate in the store itself until the following spring. It often happens therefore that almost all the corners of the store are teeming with such pupas, the destruction of which before the spring becomes imperative. This is done by washing the store with a solution of lime to which a small quantity of carbolic acid is added. The washing must be done with a hard bristly brush. It is, nevertheless, always best to hasten the

(1) Revue des sciences naturelles appliquées, 1892, July, page 31.
(2) Décaux recommends also, as we have said, the spread of soot.
(3) To prevent the flies from coming out, Décaux recommends that the windows of the stores should always be kept closed or covered by cloth or by a dense wire net.

grinding of olives as much as possible, because in this way, by destroying the worms and pupas which are in them, the spread of the insect by the gathered fruit is prevented.

These are the most effectual and approved measures which have hitherto been proposed and effectually applied against the *Dacus* of the olive. Experience, which is the best criterion, has proved their utility. Consequently, their assiduous, persistent and simultaneous application may easily free every olive grove from this scourge, against which nature itself seems to have sufficiently provided. Because for the restriction of the excessive multiplication of this parasite, besides the benefit which may be derived by atmospheric changes and especially by the sharp cold, which seems to be an implacable enemy to the *Dacus*, and which periodically visits the olive belt, there come as auxiliaries insectivorous birds and some insects (*Eulophus pectinicornis. Ephialtes divenator*, etc.), which are fed and multiplied at the expense of the *Dacus*. Exactly on account of all these agencies there is sometimes observed the almost complete disappearance of this insect from entire olive-growing districts without the application of any means whatsoever.

The Psylla is an insect which often occasions great injuries to the olive production because it manifests itself at the time of the flowering of the tree, of which it attacks principally the flowers and thus prevents the formation of the fruit. This insect is a hemipterous, belonging to the family of *Psyllidae* and named *Psylla Oleae* (*Forst.*)

The disease occasioned by this insect seems to have been known to the ancients ; because, no doubt, it is to this that Theophrastus refers, when he says that "it is occasioned by a dampness in the air round about the olive trees, and that it destroys the fruit" (1). They called it *arachnium* in consequence of the cobweb or rather cotton-like substance which these *Psylla* secrete and which, as Pliny observes (2), "covers up the fruit and smothers it."

Fig. 10.
A flowering branch of the olive and a considerably magnified *Psylla* in its perfect form.

This disease is well known throughout the East. It is very often to be met with in Italy (bambacella, cotonello), in Spain (pulgillo del olivo), and in France (neiroun, sauteret, blanchet).

This *Psylla* in its perfect form is nearly one centimetre long and resembles somewhat a very small Cicada. (Fig. 10). It is generally of a beautiful light green colour, but it bears here and there some yellow spots. Its small wings are transparent and disposed in the form of a roof. By their help it flies about but with some difficulty and not to

(1) Causis Plant. 5, 10, 2.
(2) Hist. Nat. 17, 37, 11. Pliny calls this disease *Araneum*.

great distances. It has also the property of leaping, but in any case it moves about with difficulty. This is exactly what prevents its rapid spread.

The *Psylla* is very prolific and breeds many times during the same year. According to Costa some insects of the last breed hibernate on the branches of the olive tree, and early in the spring, as soon as the flowers appear, the fecundated females deposit by them their little eggs, which they cover by an abundant cotton-like substance secreted from their hind parts.

(Fig. 11).

Out of these little eggs quickly come out the young *Psyllae*, and as they too, from the time of their hatching until their full growth, secrete abundant cotton-like substance (Fig. 11), by it the flowers and the young fruit of the olive tree are covered and thus their regular growth and development is impeded (Fig. 12). The young *Psyllae*, protected by this substance against the dew and the rays of the sun, grow and are transformed sucking the sap particularly of the flowers and of the young fruit and their pedicels, injuring and sometimes decimating the crop, because most of the flowers become abortive and the fruit saved remains small and atrophied.

(Fig. 12).
A fruit-bearing branch of the olive attacked by the *Psylla*.

With favourable weather many breeds succeed each other until the month of July, when some of the fully developed *Psyllae* of the last breed retire in order to hibernate.

The weather most favourable to the development of this disease is a cool but not rainy spring, at least during the months of March and April. The rains which usually come on during these months prove beneficial, because they carry away the cotton-like substance and the insects which are under it. The *Psyllae* which may have been saved on the trees after a heavy rain, remaining stripped, cannot for long resist the action of the night dew and of the heat of the day.

In order to restrict the spread of the disease, Costa (1) recommends to gather without delay and burn every sprout of the olive tree on which the cotton-like substance, characteristic of the disease should appear. Powerful washings of the attacked trees even with mere water, driven out by a strong garden pump, would, of course, also prove effectual. This last means could be used withont any injury to the flowers if applied before they open. But both these means, from an economical point of view, are applicable only to well-maintained olive groves or

(1) Degli insetti che attaccano l' albero ed il frutto dell' olivo, etc., page 63.

during years in which the production of olives is expected to be very large.

Fig. 13.

Tumours. On the trunks, the branches and especially on the twigs of the olive trees grow not seldom some woody or fleshy excrescences more or less round, having an anomalous and rough surface. (Fig. 13). When these grow and attack the twigs all round, they dry them up or else they weaken them to such an extent that they are broken even by the lightest blow of wind.

Sometimes this disease of the olive tree extends itself considerably and persists for many years in succession in impeding the regular fructification and greatly exhausting the tree.

This disease is not rare among us and is often to be met with in Italy (rogna) and France (tumeurs, tuberosités), its real origin is not, however, as yet ascertained, and for this reason it is in different ways explained by those who have described it. Thus Bizzarri (1) attributes these tumours of the olive tree to chills, hail or to the injuries inflicted to the branches during the gathering of the fruit by beating. Caruso (2) thinks that its causes are the last two circumstances as well as excessive trimming. Aloi (3) ascribes it to the irregular plastic elaboration which is occasioned by the bad assimilation of the sap. Coutance (4) basing himself on the opinions of Bernard and of the Spainiard Tablada, attributes the tumours to the attacks of the first breed of the *Tinea* (5).

But this disease appears also on the pomegranate tree (6), on the *Pinus halepensis* and on the vine. The tumours on the *Pinus halepensis* and on the vine have been examined by many (7), some of whom attribute them to attacks of bacteria (8). To this same cause tumours of the olive tree are also attributed by Prillieux (9).

Nevertheless, bacteria are not always to be met with in the tumours of the olive and of the other trees and bushes which are attacked by this disease nor is the disease communicated by inoculation, as I once tried on the vine (10), nor does the attack of insects or frost always precede the appearance of the disease, the only cause of which does not seem to be the gathering of olives by beating, considering that this disease attacks even trees which have not been beaten or wounded in any other way (by excessive trimming, hail, etc.)

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(1) La coltivazione dell' olivo, page 200.
(2) Dell' olivo, page 164
(3) La coltivazione dell' olivo, page 66.
(4) L' olivier, page 220.
(5) See page 29.
(6) I met the tumour on pomegranates in Cyprus.
(7) "*Helliniki Georgia*" of 1894, page 373.
(8) *Idem* 1890, page 150.
(9) Comptes Rendus CVII., No. 22.
(10) "*Helliniki Georgia*" of 1894, page 374.

Consequently, until fresh and more exact researches have been made, we cannot accept as indisputable any of the above-mentioned opinions with respect to the origin of the tumours of the olive tree. And as the unristricted development of this disease greatly weakens the tree, the sap of which is consumed in the formation and growth of the tumours, it is necessary to cut off all branches bearing such tumours and remove them with a sharp instrument, along with a part of the wood under them, from the trunk and the principal branches. This must be done after the gathering of the fruit, during the month of January, or February at the latest, and the parts detached must be burnt.

Diseases of the Apple Tree. At Prodromos apple trees are extensively cultivated. These trees are attacked chiefly by the *Ermin Moth* and by the *Root-rot*. These diseases are common and very injurious everywhere in Europe and in the East, where the cultivation of apple trees is very extensive.

Ermin Moth. The chief characteristic of this disease is the covering, early in the spring, of the young branches of this tree by a cobweb-like network made by the caterpillars of a microlepidopterous insect called *Hyponomeuta malinellus. Zell.*, living in numberless colonies (1) and fed on the leaves of the tree. The attack of the apple tree in consecutive years may bring about its utter exhaustion and finally its death.

The little eggs of the Ermin Moth deposited on the branches of the tree about the middle or the end of the month of June are hatched about the end of the following March or the beginning of April, when sprouting of the apple tree begins. The small caterpillars then borne forth, forming numerous colonies at the extremities of the branches, make a cobweb-like net, with which they cover the flowers and leaves growing therefrom. In this net they remain eating the enclosed flowers and leaves. When the sprouts of a branch have been exhausted, the caterpillars, which are still young, abandon it and remove to another branch still intact, which they cover by a new net.

This is repeated five or six times for about one month, after which the caterpillars attain to their greatest size and are ready to pass into the chrysalis state. For this purpose about the end of April or the beginning of May, within the nest itself and by the side of each other the caterpillars weave their white silky cocoons, in which they pass into the chysalis state and remain for about 15 days, after which time they come out of them in the state of moth. The Ermin Moth is about one centimetre long, entirely white, and has on its body and on the upper surface of the first pair of its little wings many black spots.

By this time apple trees which have been persistently attacked seem dried up and look as though covered by snow, because of the many nets which remain empty on them. Around these trees thousands of moths are flying, which after copulation deposit on the branches their little eggs. These, as we have seen, are hatched early in the following spring.

(1) Synonymes: Hyponomeuta padellus; in French, yponomeute cousine; in Italian, Tignuola del melo; in English, Ermin Moth; and in German, Apfelbaum Gespinstmotte.

Against this insect they have successfully applied in Cyprus sprayings with solution of Paris green in a preparation of thin paste, of which we have already spoken (1), and which is sold by the makers Blundell, Spence & Co. (9, Upper Thames St., London), in bottles containing 7lbs. (about 2½ okes) at 6s. each (7½ frs.) Fifteen or twenty drams of this preparation are dissolved in 100 okes of water.

This paste has the advantage of being dissolved in water easily and more thoroughly than the Paris green in a state of powder, the dissolving of which is more dangerous.

Paris green is a very strong poison, and for this reason the caterpillars which eat the leaves sprayed with a solution of this substance quickly die. If for three or four days after the application of the remedy it does not rain, one spraying with this solution is sufficient to destroy all caterpillars which may be on the tree.

Besides this well tried remedy use is also made against the Ermin Moth of a solution of Pitteleina. Berlese (2), who devised and tried this remedy, says that one good spraying with a solution containing only one per cent. of Pitteleina quickly cures the apple trees.

The Pitteleina is sold in tins containing one to ten kilogr. at one franc per kilogr. and is to be had at the makers Messrs. Petrobelli & Co., Padua (Italy).

Both the above solutions are applied by spraying pumps, to which long pipes made of metal or caoutchoue fixed to reeds, are attached (3). In this way the spraying even of the highest trees becomes possible. It is necessary to spray first the higher, and afterwards the lower parts of the tree.

The Root-rot is a very old disease (4), known everywhere (5), attacking most plants and, particularly, the perennial ones. I found it on some apple trees at Prodromos, and, as I was told, it often makes its appearance in the apple groves of that village.

As its name implies, the chief and characteristic symptom of this disease is the rotting of the roots occassioned by cryptogamic plants and, particularly, by the *Dematophora necatrix*, the life of which has been described in detail first by Hartig (6) and afterwards by Vialla (7). This parasite quickly grows and propagates itself, especially during wet years in soils naturally damp as well as in those which are irrigated and are not porous.

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(1) See page 15.

(2) La tignnola del melo ed il modo di combatterla. Padua, 1893.

(3) In hot countries all articles made of caoutchoue must be kept in cool cellars, or, better still, sunk in water. But in any case they are quickly worn out and become useless. For this reason in this case pipes of metal must be preferred to those of caoutchoue.

(4) Theophrastus. Hist. Plant. 4, 14, 2, etc., and Caus. Plant. 5, 9, 1.

(5) In France by the name of Pourridié; in Italy by that of Marciume delle radici; in England by the name of Root-rot and in Germany by that of Harzsticken.

(6) Der Würzelpilz des weinstockes. Berlin, 1883.

(7) Monographie du pourridié. Annales de l'Ecole Nationale d' Agriculture de Montpellier, 1891.

The root-rot sometimes occasions great injuries, particularly to nurseries, vineyards and fruit groves situated in such soils.

During the first year of the attack the tree usually flowers and fructifies abundantly. In the autumn or the following spring the sprouting is defective ; its sprouts remain short and sickly and many of them get dry. During this period most of its roots are already partially rotten or altogether dead, when the trunk is detached from the ground without much resistance.

By uprooting the tree we observe that by this time it has only a few roots and they are half dead and more or less black externally. The part of the trunk immediately above the roots is covered by a blackish or easily detached bark. By cutting off the trunk near the surface of the ground we observe that the wood is altered in colour and more or less spongy and that it usually emits a dark and gummy liquid. Finally, by attentively examining the roots of the attacked tree, we discern here and there a white and sinewy substance branching off and running over the surface of the bark or under it. This substance is the *mycelium* of the parasite, which causes the root-rot.

This disease in soils favourable for its propagation is easily spread from one tree to another by means of the roots which meet under the surface of the ground. The rapidity of the propagation is proportionate to the proximity of the trees—trees densely planted are attacked quicker.

The suspension of irrigation, draining and the ventilation of the soil by digging round the trees may prevent the progress of the disease. By these means trees recently attacked may sometimes be saved. Nevertheless, those which are considerably attacked must be immediately uprooted and all their roots taken away from the soil and burnt. The hollows out of which the diseased trees have been taken should also be left open throughout the summer.

According to Vialla, in grounds attacked by root-rot no plants subject to this disease should be cultivated for two or three years. In such grounds only cereals may with impunity be cultivated (1).

Schizoneura lanigera. I have come across this insect at Tricomo on apple trees imported from abroad a few years before. As the *Schizoneura* is most dangerous, and by being propagated to other districts of the Island, particularly, the coldest, may become here as elsewhere (2) an implacable scourge of the apple tree, I have thought it necessary to say a few words about it also, in order that the necessary measures may in time be taken for fully disinfecting the few trees which are now in the Island attacked by it.

The *Schizoneura* of the apple tree is a small plant louse, which in many respects greatly resembles the Phylloxera. This louse belongs to the family of the *Schizoneuridae* and is called *Schizoneura lanigera.*

(1) Monographie du Pourridié, page 95.

(2) The Schizoneura lanigera is now met with wherever the apple tree is cultivated. The origin of this insect is disputed ; nevertheless, it seems probable that America is its mother-country, from where about the end of last century (1789), it was for the first time introduced into England, where it was then named American Blight (Harris. Insects injurious to vegetation, page 242). In the United States it is called Woolly aphis or Woolly apple tree louse : in Germany Blutlaus ; in France, Puceron lanigère ; in Italy, Afide lamigero and the disease Muffa del melo.

Hausm., in consequence of the copious cottony substance it secretes and by which it is covered, especially during the summer.

As Lignières (1) rightly observes, the evolution of this insect under different climatic influences greatly varies in different countries. To this circumstance are due the wholly opposite opinions held with respect to the place where the females hibernate.

These I have repeatedly found on the annual and the older branches, on the trunk as well as by and on the roots themselves under the surface of the ground ; but always safely placed in the clefts of the bark or the foldings of the tumours, the formation of which these insects occasion by absorbing the sap of the tree.

Fig. 14.
A branch of apple tree attacked by the *Schizoneura*. A *schizoneura* considerably magnified.

About the middle of the month of April or the beginning of May the apterous and asexual mothers, coming out of their crypts, ascend and settle on the younger branches of the apple tree, where they bear forth at intervals up to fifty young ones. These become of age within twenty days at the most, when they, in their turn, without the intervention of a male, bear forth new insects equally apterous and asexual. In this way until the month of October (and in hot climates sometimes until December) ten to fifteen breeds of *Schisoneura* succeed each other, and its numerous colonies take possession of almost all the branches of the apple tree, which, on account of the copious cottony substance which these insects secrete, often looks from a distance as though covered by snow in the midst of summer (Fig. 14).

About the end of summer the winged *Schisoneure* make their appearance and they bear forth 6-8 sexual insects. The females, after their impregnation, which takes place in October or November, lay only one egg each, which they cover with a cottony substance. This egg is hatched in the following spring, and out of it comes an apterous asexual *Schisoneura*.

The apple tree when attacked is slowly but steadily exhausted. After the attacks of two or three years the tree ceases bearing fruit and finally it dies. In those parts of the apple tree in which the numerous colonies of *Schisoneura* settle the bark swells or bursts and tumours more or less large are formed, for the formation of which the sap of the tree is in vain exhausted.

The utter destruction of the *Schizoneura* becomes exceedingly difficult on account of the abundant cottony substance by which it is covered, and which is not penetrated by liquid insecticides not containing spirits, petroleum or heavy oils. By these the cottony substance

(1) Rapport sur l'évolution du puceron lanigère. Bulletin du Ministère d' Agriculture, 1895, page 826.

is easily soaked, and the insects under it attacked. Therefore of these substances thinned in water (the last two with the help of soap), and, particularly, of Pitteleina (1), successful use may be made against the *Schizoneura* about the end of winter; before the insect begins to multiply itself and before sprouting.

Successive sprayings with these substances of the few apple trees as yet attacked by *Schizoneura* in Cyprus, as well as of the ground around them may prevent the spread of the disease. But if the apple trees already attacked by this insect in the Island are only the two or three, which I met at Tricomo, it would be best, at the surest means to put a stop to the evil in its very origin, by the immediately uprooting and burning the diseased trees. To prevent the re-importation of this disease, it is necessary to prohibit the importation of apple trees into Cyprus from all parts whatsoever.

Diseases of Vegetables and Pulse. Some of the vegetables and pulse, which are extensively cultivated in Cyprus, I have found considerably attacked by the *Orobanche* and the *Mole-cricket.*

Orobanche. I have observed that the *Orobanche* attacks many plants, cultivated or not, and with intensity, beans and, particularly, potatoes, in spite of the well known poisonous properties of solanine, which they in abundance contain. For this reason this fact has surprised many scientists, to whom I have communicated it (2).

There are many species of *Orobanche*, which are dicotyledonous parasites belonging to the family of *Orobancheae*, which is sub-divided into four species (3).

These herbaceous plants are annual if the plant on which they live is annual, and perennial if the plant is perennial.

The *Orobanchae* are never green, but sometimes violet, sometimes reddish and sometimes yellowish. Their rapidly growing branchless or branching stalk is fleshy and tender, resembles that of the cultivated asparagus and bears, instead of leaves, alternate small scales. The flower, solitary or spiked, is hermaphrodite and sometimes fragrant; its colour is more or less deeply yellow, red or blue. Their fruit is a bivalve capsule, containing a multitude of very small seeds, which, on account of their smallness and lightness, are easily carried away by the winds and scattered about to great distances.

But although very fine, the seed of the *Orobanchae*, covered as it is by a very hard membrane, can preserve its germinating power for a long time, and it germinates whenever it happens to be in contact with the root of a plant on which the *Orobanche* grows.

Out of the germinating seed of this parasite comes a sucking organ, which enters into the root of the plant, outside which a tubercle is formed. Out of this grows the flower-bearing stalk of the parasite which

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(1) See page 14.

(2) Bulletin des séances de la Société Nationale d'Agriculture de France, 1895, page 283.

(3) *Orobanche, Lathraea, Clandestina, Phelipaea.*

comes and blossoms out of the surface of the ground, as well as a network of roots which covers the root of the attacked plant on which the parasite feeds.

Plants thus attacked when still young, wither and at last are dried up—for the most part before their fructification.

It was formerly supposed by some that by cutting off in time its stalk the *Orobanche* is dried, and consequently, the plant attacked by it is saved; but by subsequent researches it has been proved that this parasite has the property of pushing forth new stalks from its root, which may produce many tubercles, even if it attacks annual plants, such as beans, tobacco, hemp, etc.

The commonest and most destructive *Orobanche* amongst us is that of beans (*Orobanche major* or *O. speciosa*), which attacks particularly beans, but also most of the other kinds of pulse. This, or rather a variety of this, is that which attacks potatoes in Cyprus, particularly in the district of Prodrómos.

The *Orobanche* was perfectly well known to the ancients. Theophrastus mentions it as attacking the vetch, from which comes its name (Ὄροβος and ἄγχω=stifle (1). Dioscorides, who describes it, says that the Cypriotes called it *θυρσίνη*, and that commonly it was then called as to day λύκος (2). Lastly, in "Geoponica" it is mentioned as living parasitically on every kind of pulse, for which reason it was also called ὀσπριολέων (lion of pulse, 3).

This parasite is considered as the most dangerous enemy to beans, because often entire fields attacked by it are destroyed. The fields then become so vitiated that for many years afterwards the sowing of pulse in them again becomes unprofitable. The same facts are recorded with regard to the injuries caused by the *Orobanche* to beans and potatoes in Cyprus.

Of the various means proposed for restricting the injuries occasioned by this parasite and for preventing its propagation, the most effectual, comparatively, are the following:

(1). To sow, for at least three years, products which are not attacked by the *Orobanche* in a field where grow plants attacked by it. If, for instance, beans sown in a certain field are attacked by the *Orobanche*, neither pulse nor potatoes must be sown in it for at least three years, but other products which are not attacked by this parasite, such as cereals, cotton, sesame, etc.

(2). The field, in which are sown plants subject to the attacks of the *Orobanche*, must be well manured, particularly with substances containing potash and phosphates, viz.: with ashes of wood or charcoal and finely ground bones; because it has been observed that the attack of the *Orobanche* is always weaker in rich soils, and more intense in poor ones. This happens either on account of the unsuitableness of the

(1) Hist. Plant. 5. 15, 5.
(2) De Mat. Med. Book B., Chapter 171.
(3) "Geoponica," 2, 42.

more fertile, and, consequently, comparatively humid soils, for the parasite, or because in such soils plants grow more robust and resist better the attacks.

(3). The soaking of the seed of pulse for 12 hours in a solution containing 5 per cent. of sulphate of copper, because it has been observed that often the seed proceeding from a cultivation attacked by the *Orobanche* bears the very fine seeds of the parasite in the form of powder, and they are said to be destroyed by the solution of sulphate of copper, whereas the seed of pulse is never attacked by the solution during the soaking (1). It is, of course, unnecessary to add, that if we are to sow a field in which the *Orobanche* had been developed with some product subject to its attacks (which, by-the-bye, we by no means recommend) this means may serve only as an auxiliary.

Lastly, an effective means is to carefully cut off the stalks of the parasite before blossoming, because in this way the seeding and spread of the *Orobanche* is impeded. But this effective operation must be many times repeated during the period of vegetation of the attacked plant, because throughout this period new parasites may be developed, which, as we have seen, may otherwise yield a second and third stalk, especially when the first has been cut off. For this reason, with regard to beans, the cultivator from the month of February must visit his fields at least once a week, and with a secateur or with a sharp pruning knife cut off (and not pull off) the stalks of the *Orobanche* which are naturally tender and can easily be distinguished before blossoming. When cut off these stalks are left on the spot in order to be used as manure, or are gathered and given to cattle, which greedily eat them. The stalks of the *Orobanche* of beans, according to Dioscorides, are eaten raw or boiled as those of asparagus, which they resemble with respect to tenderness and shape.

If, during these weekly visits, stalks of *Orobanche* somewhat in blossom should be met with, they should be put with care in a bag, and then carried out of the field and burnt, in order to prevent the spread of their seed which may perhaps, have matured.

The *Mole-cricket* (*Gryllotalpa vulgaris*) is a real scourge to gardens and seedlings in general.

This orthopterous insect, which in ancient times (2) was very well known throughout the East, is met with in almost every part of Europe (3) in plains, in light soils. It seldom lives in clayey and compact soils, and very seldon in mountainous Districts.

Manure, and, consequently, manured soil seams to be its pre-eminently favourite abode. The presence of the mole-cricket in a field is easily discerned from the light elevation of the surface of the ground in irregular lines crossing each other, which elevation is occasioned by the pushing up of the soil by the insect in digging through its subterraneous passages.

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(1) Potatoes cannot be subjected to this treatment without injury to their sprouts, as I have ascertained myself.

(2) Theophrastus. Hist. Plant. 7, 5, 4. Geoponica. 12, 9.

(3) It is called in French *Courtilière*, in English *Mole-cricket*, in German *Gemeine Maulwarfsgrille* and in Italian *Grillotalpa*.

In its perfect form the mole-cricket is 4 to 5 centimetres long, of a deep yellow colour, has a conical head, projecting eyes, long antennae, strong jaws, two pairs of wings, of which the lower ones are folded and somewhat longer than the body, and the upper ones shorter, extended and yellowish in colour. His six feet are strong; his two fore ones being flat and bearing at the extremities each four strong and sharp hooks, by which, a little under the surface of the ground, he digs passages, destroying thus the roots of near plants and even uprooting them.

The females, from the middle or the end of March, begin depositing their eggs, 250-300 in number, in a rut made in the ground for the purpose, or, by preference, in a dung-heap and in a depth of 25 to 30 centimetres. These eggs in 20-25 days are hatched and the young, then perfectly white, mole-crickets, coming out of them, live together, superintended and probably fed by their mother until the beginning of June, when they seperate from each other. These young insects, until they become of age, change their skin repeatedly, and 24 months after they have been hatched they are perfect and ready for reproduction. So that for two whole years they cause damages, not unmixed with some benefit to agriculturists, because the mole-cricket, as has many times been observed, is a carnivorous insect.

Living for the most part in the earth and digging up winding passages, which it utilises also as a refuge, it occupies itself especially in pursuing other insects and worms; but in the absence of them it does not despise even tender plants. During the night for the most part it comes out of the ground in search of the insects which live on its surface.

But the great injuries occasioned by it consists in the continual disturbance of the soil of planted or sown fields. Of course this impedes the shooting of the seeds or the development of growing plants. Many a time have I happened to see perfectly successful seedlings to be utterly destroyed by the mole-cricket within a few days.

Of the very numerous means proposed against this insect the most practical and effectual is, unquestionably, that which consists in injections of carbon bisulphide in the fields attacked, in the proportion of 20 grams for every square metre. The vapours of this greatly insecticide liquid kill or drive away the mole-crickets existing in the fields as well as every other insect. These injections are done by some special implements called by the French Pal-injecteurs (1).

A more handy means is that of mixing the dung intended for manureing the field with five per cent. of petroleum. The smell of petroleum thus imparted to the ground drives away the mole-crickets. The use of petroleum for this purpose becomes more effective if, instead of manure, we make use of woollen rags, which are an excellent manure and which absorb the petroleum more easily and retain it a longer time. These rags are split into small pieces and soaked in petroleum are scattered over the infected field, which we intend to sow or to plant, and afterwards they get buried when the soil is turned by the plough or the spade.

If the field is already sown or planted, and the mole-cricket makes its appearance, the ravages of which we wish to prevent, we bury here and

(1) See "*Helliniki Georgia*" of 1888, pages 504-509.

there in the ground small pieces of woollen rags soaked in petroleum ; and in order that these may not be removed during the hoeings, we fix in the ground over each of them a stick for the guidance of the labourer.

Diseases of Cereals. In Cyprus standing cereals are for a long time past attacked by the caterpillar of a microlepidopterous insect, which in some districts of the Island occasions really serious damages.

A specimen of this insect was sent to England in 1889. Stainton, a great authority on the *Tineidae*, who examined it, said that it is a species of *Oecophora* (*Oe. temperatella*, *Lederer)*, to be met with in Beyrouth, Lydia and Palestine ; and Arthur E. Shipley, who furnished this information, pointed out the necessity of ascertaining (*a*) the place where this insect transforms itself into chrysalis, and the time during which it remains in this form, (*b*) the place where the moth deposits its eggs and the manner in which they are deposited and (*c*) the form in which the insect hibernates. So long as these facts remain unknown, it is impossible, Shipley says, to suggest a remedy (1).

The short time during which I staid in the Island has not permitted me to examine and ascertain more in detail everything concerning the life of this insect, which is met with only in Cyprus and the neighbouring Asiatic countries.

From the information I have gathered and the observation which I was able to make on the spot, it results that the caterpillar of the *Oecophora* makes its appearance by attacking the yet young plants of barley, oats and, particularly, of corn, from the middle of the month of January, and about the end of March the moth appears. This moth I found (29 March) near Lefconicon feeding on the flowers on the *Convolvulus Arvensis* and of a species of Asphodel, growing in fields which had already been destroyed by the caterpillars of this insect.

I carefully examined the stalks of many attacked wheat plants, in order to ascertain whether the insect undergoes its transformation on them or elsewhere, but found no chrysalis—was it because the season had passed ?—nor any remains of the transformation (hollow cocoons or shells of chrysalis) have I discovered. However, having put in a small bag some attacked stalks of corn, without soil and roots, and a few days afterwards having returned to Nicosia, I found amongst them some moths of the *Oecophora*, which during this intervening time transformed themselves into chrysalides, and which, no doubt, were on the plants.

These incomplete observations do not certainly solve the question as to where the *Oecophora* weaves its cocoon ; nevertheless I mention them in order that those who take an interest in the matter may be guided in further researches on this subject. It is, moreover, necessary to ascertain the place in which the *Oecophora* deposits its eggs and the number of its breeds, because it is not unlikely that this insect may make its appearance many times during the same year.

Early sown cereals resist the attacks of the *Oecophora*, because when its caterpillar appears the plants are already sufficiently grown for their further development not to be impeded by the attacks of this insect.

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(1) "Bulletin of Miscellaneous information." Royal Gardens, Kew, London, 1889, page 133.

It has, moreover, been observed that deep ploughing frees the field for some years from the attacks of this parasite. From this fact one may conclude that the eggs of the insect are deposited on the surface of the attacked field, on the soil or on the dry weeds and the stalks of cereals, and that, these being turned over, the eggs are destroyed by being carried away to a considerable depth from the surface of the ground. This remark is an additional argument in favour of the introduction into Cyprus of more perfect ploughs by which a deeper ploughing and a more thorough turning over of the soil will be attained (1).

It has also been ascertained that by allowing the field to remain fallow for three years or cultivating in it other products, excepting corn, barley and oats, one contributes to the destruction of the *Oecophora*, which is thus starved to death. But certain fields cannot afford to remain fallow for three whole years, or cannot profitably be sown but with cereals. In such lands the cultivation of the, unknown in Cyprus, rye may be tried, which, having a somewhat tougher stalk, may probably resist the attacks of the *Oecophora*.

In fields attacked by this insect it would be well, after gathering the crop, to burn the standing stalks, along with which would be burnt all or most of the eggs of the *Oecophora*, which, as we have seen, according to all probability, are deposited on the surface of the field. Moreover, this burning, used in great many places, will also contribute to facilitate the ploughing (when the stalk is high), to destroy the seeds of weeds, and to utilise more quickly the various vegetable substances left on the field after gathering, which, when burnt, are converted into ashes, serving as an excellent manure for the sowing immediately following.

These are the principal diseases of plants which I met with or of which they spoke to me during my stay in Cyprus, and with the description of which this third and last part of my Report closes.

Most of the diseases by the diligent and systematic application of the measures pointed out here in detail may be successfully combated, provided landlords bear always in mind the old saying "Σὺν Αθηνᾷ καὶ χεῖρα κίνει."

The plant disease most difficult to deal with is that caused to the vine by the Phylloxera; but, fortunately, the Island is free from this scourge, thanks to the strict measures taken by the Government against the invasion of this insect.

One of these measures is the prohibition of importation of seeds from abroad. The necessity of the free importation of seeds from any place whatsoever, and especially, of seed of vegetables, I pointed out in a preceding chapter, in which I also promised to prove the absence of all danger to propagate the Phylloxera (2) by such an importation. But in consequence of the dimensions this Report has taken it would not be allowed to me to do this now but only by the following few words.

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(1) See Part A of this Report, page 17.
(2) See Part B of this Report, page 20.

At the International Phylloxeric Congresses held at Lausane and Berne the dry seeds not only were not condemned as dangerous, viz.: as capable of communicating the Phylloxera, but also Governments, as well as landowners of countries not suffering from Phylloxera were urged to multiply resisting vines by seeds coming from any parts whatsoever (1). Besides, since it is permitted to import into Cyprus from all parts pulse and cereals, which are also seeds, it is not reasonable to prohibit the importation of seeds of vegetables or other plants, the spread of the cultivation of which all over the Island is most necessary.

(1) Acts du Congrès phyllox. de Lausane, 1877, page 110—Actes de la Conférence phylloxerique internationale réunie à Berne, 1878, page 65.

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